

TRANSACTIONS

OF THE

ROYAL SOCIETY OF EDINBURGH.

V O L. II.



EDINBURGH:

PRINTED FOR T. CADELL, IN THE STRAND, LONDON;

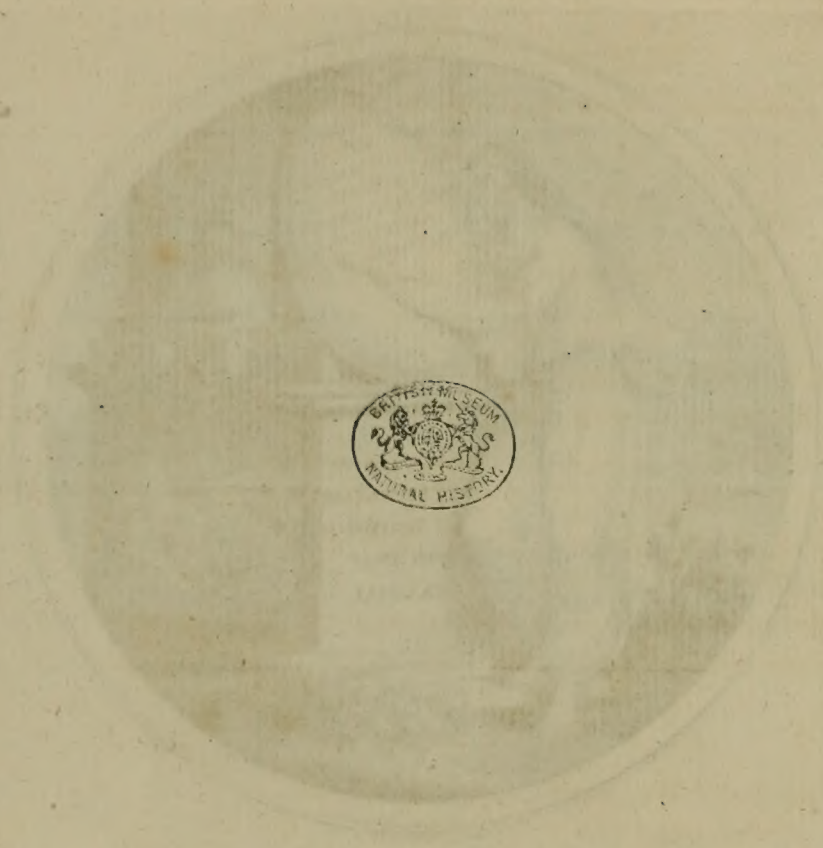
AND

J. DICKSON, ROYAL EXCHANGE, EDINBURGH.

M.DCC.XC.

ROYAL SOCIETY OF EDINBURGH

1841



EDINBURGH

PRINTED FOR T. CADELL, IN THE STRAND, LONDON.

J. DICKSON, ROYAL SOCIETY OF EDINBURGH

1841

C O N T E N T S

OF THE

S E C O N D V O L U M E.

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TRANS-

H I S T O R Y

O F

T H E S O C I E T Y.

LITERARY Class. Mr DALZEL read a Philological Dissertation on certain Analogies observed by the Greeks in the use of their Letters; and particularly of the Letter Σ; which is printed in this volume. [No. IV. *Lit. Cl.*]

1785.
Dec. 19.
Mr Dalzel on
the Greek Σ.

Physical Class. THE Secretary read a Letter to the Society, from the Reverend Dr ROBERTSON, inclosing one from Mr FRASER, Under-secretary of State, and one from M. ANISSON of Paris, with a Memoir on the subject of Printing.

1786.
Jan. 2.
Memoir on
printing.

Lit. Cl. Dr GREGORY read a continuation of his Essay on the general Notion of the Relation of Cause and Effect. [See Vol. I. Hist. Nov. 15. 1784. and March 21. 1785.]

Jan. 16.
Dr Gregory on
cause and effect.

1786.

Jan. 23.

General Meeting.

A GENERAL Meeting of the Royal Society was held for the election of Members. [See Vol. I. Appendix to the History of the Society.]

Feb. 7.

Dr Home on Amaurosis.

Phyf. Cl. Dr FRANCIS HOME read a paper on *Amaurosis*.

Dr Small's demonstrations of Dr Stewart's theorems.

THE Reverend Dr SMALL read the Heads of a paper containing Demonstrations of twenty-eight of the Theorems published in 1746, by the late Reverend Dr MATTHEW STEWART, Professor of Mathematics in the University of Edinburgh. The Demonstrations are printed in this volume. [No. XII. *Phyf. Cl.*]

Feb. 20.

Prof. Young on the Greek middle voice.

Lit. Cl. Mr DALZEL, one of the Secretaries, read part of an Essay on the Middle Voice of the Greek Verb, written by Professor JOHN YOUNG, of the University of Glasgow. On account of some additions intended to be made by the Author, the publication of this Essay is postponed to a subsequent volume of the Transactions.

March 6.

Mr Robison on the Georgium Sidus.

Phyf. Cl. Mr Professor ROBISON read a paper on the Orbit and Motion of the new Planet, the *Georgium Sidus*; which is printed in the first volume of the Transactions of this Society. [Vol. I. No. XI. *Phyf. Cl.*]

March 20.

Dr Macfarlan on the Land-tax.

Lit. Cl. THE Reverend Dr MACFARLAN read a Dissertation respecting an equal Assessment of the Land-tax.

Prof. Young on the Greek middle voice.

Mr DALZEL read a continuation of Mr Professor YOUNG's Essay on the Middle Voice of the Greek Verb. [See *supra*, Feb. 20.]

April 3.
Mr Playfair's life of Dr Matthew Stewart.

Phyf. Cl. The Reverend Mr Professor PLAYFAIR read an Account of the Life and Writings of the late Reverend Dr MATTHEW STEWART, Professor of Mathematics in the University of

of Edinburgh. This Account is published in the first volume of the Transactions of this Society. [History of the Society, Appendix.]

1786.

Dr JAMES ANDERSON read an Essay, containing Observations and Experiments on the Culture of Potatoes. He did not chuse that any abstract of this Essay should be published.

April 3.
Dr Anderson
on the culture
of potatoes.

THE Secretary presented to the Society two books, one in Latin, *De Herpete*, and the other in French, *Sur la Petite Verole*, written by M. ROUSSEL, Royal Professor of Medicine in the University of Caen in Normandy, sent by him to the Royal Society of Edinburgh.

Books present-
ed to the Soci-
ety.

Lit. Cl. Mr DALZEL read the remainder of Mr Professor YOUNG's Essay on the Greek Middle Voice. [See *supra*, March 20.]

April 17.
Prof. Young on
the Greek mid-
dle voice.

Dr HUTTON read part of a Dissertation on Written Language as a Sign of Speech.

June 19.
Dr Hutton on
written lan-
guage.

It is the purpose of this paper to show, in what manner we arrive at the knowledge of simple sounds, by the analytical examination of our speech, or the resolution of it into its principles. These simple sounds may be represented to the sight, by means of certain figures, appropriated to those sounds. Such figures then become the principles, *first*, of the writing of our speech, and, *2dly*, of the reading of our written language.

THERE being no less than four different methods of analysing speech for the purpose of typifying language, these are examined with a view to understand the advantages and disadvantages that may attend each of those particular methods, according to the following order: *first*, The analysing of speech into parts, each of which is the sign of a distinct thought; *2dly*, into words, the constituent parts of our expressed thoughts;

3dly,

3dly, into syllables, or articulate sounds, the constituent parts of words; and, *lastly*, into letters, or inarticulate sounds, the constituent parts of syllables.

THERE are only two of those practicable methods of typifying speech, that have any peculiar advantage to recommend their use. These are the verbal method, on the one hand, and the elemental, on the other. Each of these having their peculiar advantages, are now to be mentioned.

THE advantages of the verbal method consist in this, that different nations, by this means, might communicate their desires by writing, without the knowledge of each other's speech. But the necessary disadvantage of this method is more than sufficient to counterbalance its great benefit; because, while there would not be sufficient accuracy for thus expressing every thought in writing, it would require to make it the business of a man's life to read and write. Whereas the advantage of the elemental method will appear from this, that while the commutation of our figures and our simple sounds is perfect, our speech, which is composed of those simple sounds, may be written with facility, and our written language read with absolute perfection. The benefit of this method, therefore, far more than compensates for its loss, in not serving as a mean of correspondence between foreign nations.

MUSIC and speech are next considered, in order to see their necessary connection and the difference of their principles.

THE formation of articulate expression, by means of vocal sounds and consonants, is then illustrated, in shewing the nature of our speech, as the foundation of our art of writing.

THUS, an alphabet is represented as being the work of ingenuity and wisdom, and as being, with good reason, the boast of science. The corruption, therefore, of this alphabetical method of characterising speech, is reprobated as an error prejudicial to science, and disgraceful to a nation that is wise and learned.

ORTHOGRAPHY being thus a most scientific art, it is of much importance, for the educating of a people in this art, to conform the practice strictly to the rules of science, and to have the rules of that science comprised in the knowledge of the alphabet. The alphabet is therefore now made the subject of a scientific discussion.

AN alphabet being nothing but the figured elements of speech, and speech consisting of articulated sounds, we are to examine those distinct sounds which man has it in his power to form for the purpose of his speech, and also all the practicable articulations proper for modifying his vocal sounds.

THE vocal power of man is, from experience, found to be divided into seven distinct notes, and this power is represented by a line divided into six equal parts, which forms seven equal distinctions of his perfect sounds.

THE letter *i* is here affixed to the most acute or highest of those notes of vocal sound, and *u* is the written sign affixed to the lowest, or the note which is naturally most grave. In a middle place between those two extremes, in this vocal capacity of man, is placed the sound, which is considered as corresponding to the letter *a*.

THUS, we have the radical alphabet, of the perfect vocal sound in the letters *i*, *a*, *u*. All the other sounds are then necessarily comprehended between that middle vowel and the two extremes. This determined space of vocal sound is then subdivided, the upper half, or highest space, into the vowels *e* and *η*, the lower, again, into those of *o* and *υ*.

THUS we complete the seven perfect notes of human voice or vocal sounds; and these are all defined or distinguished, in describing the gradual change or regular modification of the organ, which is necessary in sounding each.

BUT besides the seven perfect vowels which compose what may be termed the radical alphabet of human speech, there are two semitones, placed somewhere between the middle note,
and

and those on each extreme. This is exemplified in the use of speech ; although hitherto no letter has been contrived for those two distinctions of our voice, which are found in the words *this* and *thus*.

THE vocal powers of man being thus determined by nature, and defined in science, it is necessary, in order to complete the alphabet, to have the various articulators of the vocal sound examined, with a view to see how far all the organical powers of man have been practised for the purpose of his speech, and also to understand the nature of those improper articulators which may be occasionally employed.

As the distinctions in the vocal sound of man are so limited, and as the ideas to be expressed in his speech are so multifarious, it is necessary to compound those distinct sounds by means of articulations, which are either prefixed or subjoined to the expression of vocal sound.

CONSONANTS are thus formed ; and these may be distinguished in two different respects ; *first*, by the position of the organ in which they are formed ; and, *2dly*, by the operation of the breath which is employed to make them audible. It is only in thus analysing the subject, that those consonants, or the articulating powers, may be understood.

THERE are five positions of the organ by which the vocal sound is to be articulated ; and these must be understood, before the operation of the sounding organ in forming consonants, can be explained. These positions, with their respective modifications, therefore, are now to be described.

THE *first* position is formed by the close junction of the lips, so as no breath is suffered to transpire ; and this is the first modification of this position, when the passage of the breath or sound, by the nose, is stopped, and may be termed the oral modification. In this manner are formed the letters *p* and *b*.

THE

THE *second* modification of this first position, which may be termed the nasal modification, is formed by opening the communication or exit by the nose, and suffering the sound or breath to pass that way. In this case the letter *m* is founded.

THE *second* position is formed by the application of the under lip to the fore teeth of the upper jaw, which does not form an absolute interruption to the breath, but suffers it to pass in an audible manner, by means of the restraint with which it is made to pass. In this manner are produced the letters *f* and *v*.

THE *third* position is formed by a similar application of the tongue to the fore teeth, and a similar expression of the breath; thus producing the two consonants *θ* and *th*.

THE *fourth* position is formed by the application of the point or fore part of the tongue, to the root of the same teeth, or fore part of the palate. This forms a position that may be variously modified, by means of the great volubility of this member which is thus applied.

IN the *first* of these modifications, the tongue is applied closely to the palate, so as to form an absolute interruption of the breath, in a similar manner to that of the first position. It may be therefore termed the mute modification of this position. In this mute modification are formed the consonants *t* and *d*.

IN the *second* modification, the tongue is not kept close fixed to the palate, but suffers the breath to be expressed in an audible manner, similar to those of the second and third positions. This, then, may be termed the sibilating modification, by which are expressed the *s* and *z*.

IN the *third* modification, the passage of the breath between the point of the tongue and the palate is opened, and that by turns, in a quick or tremulous vibration. It may therefore be termed the vibratory modification, by which the letter *r* is formed.

IN the *fourth* modification, the passage of the breath or sound is not interrupted in any degree, but is made to pass in a very peculiar manner through the mouth. For this purpose the tongue is closely applied to the fore part of the palate, but it is retracted on each side, so as to leave an open space. A free passage is thus preserved for the breath which goes under the tongue and out of the mouth. This may be termed the liquid modification, in which is formed the sonorous letter *l*.

THE *fifth* and *last* modification is formed by shutting those lateral passages for the breath which were opened in the last modification, and at the same time suffering the sound to pass by the nasal passage, in the same manner as in the second modification of the first position. Thus we produce the letter *n*, in what may be termed the nasal modification,

THE *fifth* position is formed in all respects like the fourth, but only by a different part of the tongue and palate. There are therefore the same number of modifications in this position as in the former; and these, corresponding in their nature, may be denominated in the same manner.

WE have thus the letters *k* and *g* formed in the mute modification; the *fb* and *j* in the sibilating modification; the guttural or Northumbrian *r* in the vibratory modification; the Spanish *ll*, or the French *l mouillée*, in the liquid modification; and the guttural *n*, or English *ng*, in the nasal modification.

THE several positions of the organ, with their different modifications, being thus understood, the formation of the consonants, and articulations of voice, by the action of the breath and sound, may be now explained.

IN all the positions of the articulating organ, there is either employed the simple aspiration of the breath, or a sound produced in the windpipe, and modified in the articulating organ. Thus, in all the positions, and in several of their modifications, there are produced two distinct articulators, according either as sound is emitted along with the articulation, or only the breath employed

employed without any other sound. Hence the distinction of mutes and consonants among the articulators of voice.

BUT in each of these distinctions of mutes and consonants, there is to be made a sub-distinction, according as the articulator is either perfect or imperfect, whether as a mute or as a consonant. Each of these will now require some explanation.

THE perfect mute can only take place in those positions, in which the breath is absolutely interrupted by the close or impervious organ; and this does not happen in the second and third positions, and only in some of the modifications of the fourth and fifth.

THIS mute articulator is formed, either by interrupting the vocal sound with the close position, in which case it is a final articulator; or by beginning to express the vocal sound in this close position, when it forms, upon opening the passage, an initial articulator.

THERE are just three articulators of this kind, corresponding to the three positions in which the organ may be absolutely closed, in relation to the exit of the breath. These are *p* in the first position, *t* in the fourth position, and *k* in the fifth position.

THE imperfect mute is formed by emitting a guttural sound, or that of the windpipe, in those three positions of the mute articulator. The sound here is extremely limited; for it is necessarily restricted to that quantity of breath which may be expelled through the sounding windpipe, in compressing the air, or distending the cavity of the close organ. These short sounded articulators may therefore be termed imperfect mutes.

THE *b*, *d* and *g*, are the three imperfect mutes, corresponding to the three absolute mutes, *p*, *t*, *k*, of the first, fourth and fifth positions.

IN the fibilating articulators of the second and third positions, and of the second modification of the fourth and fifth positions, the breath may be continually emitted, either with the simple

expiration, or attended with the guttural sound. This then forms two cases of articulation, differing from each other, and also from the other two cases of mute articulation; seeing that in the present case, whether the consonant be formed with a guttural sound, or only an audible aspiration, it is a continued thing, and is not necessarily terminated, as in the mutes, by the close position of the organ. Now, as in the case of mutes, we have the distinction of perfect and imperfect, with regard to that species of letter, so, in the case of consonants, we have a species which is perfect, and one which is imperfect.

THE imperfect species of consonant-articulators, is formed in the four sibilating positions and modifications just now mentioned, *viz.* the *f* in the second position, the *θ* in the third position, the *ʃ* in the sibilating modification of the fourth, and the *ʒb* in that of the fifth position.

To perfect those four consonants, we have but to add the guttural sound to the continued expiration; and we then produce of the *f* the *v*, of the *θ* the *th*, of the *ʃ* the *z*, and of the *ʒb* the *j*.

WE have now only remaining the nasal modification of the first position, which gives the consonant *m*; the vibratory modification of the fourth and fifth positions, which give two species of the letter *r*; the liquid modifications, which give two species of the letter *l*; and the nasal modifications of those two last positions, which give two species of the letter *n*. In none of all these, is there formed a distinct articulator, by means of the simple aspiration; consequently all these are perfect consonants.

THE alphabet is thus completed, in comprehending every possible vowel and articulator which are proper for distinct speech, except the audible aspiration of the letter *b*; and this is a general articulator, which is formed in many different positions of the vocal organ.

As

As the perfect vowels may be either prolonged with the expired breath, or cut short by a change in the modifying organ, we have the means of adding quantity to the specifying sounds of speech, whereby another distinction is formed of our vocal sounds.

WE have also the power of compounding vocal sounds for the increase of the radical alphabet of vowels, which is so limited.

DIPHTHONGS and consonant-vowels, or rather articulating vowels, are formed in the following manner: The diphthong, by sounding both vowels equally in the time of one; the consonant-vowel again, by an unequal division of this time, or by sliding quickly from the position of the two extreme vowels *i* and *u*, to the vocal sound which is to be thus articulated.

HAVING thus shown that there is in nature a perfect alphabet as the principles of speech, at least that there is an alphabet which is perfectly definable in science, it is proposed to adhere strictly to this alphabet as the principles of writing, with a view to perfect speech, in having distinct sounds; and to perfect writing, in having steady principles for the commutation of sound and figure.

To give some idea of this; there are just two practicable ways of writing speech with any manner of advantage. These are either by figuring simple sounds, which is the alphabetical method, or by figuring compound sounds, which is the verbal method.

THE English method, which should be alphabetical, is not truly so, seeing it has departed egregiously from its principles, in so far adopting the other method; this is that of typifying words by means of signs, which are not expressive of the sound, but of the sense; whereas it should employ only those signs which have affixed to them an unalterable expression, not of the sense, but of the sound. We write a word by a combination of letters, not properly expressive of the speech which we pronounce,

pronounce, but conventionally specifying the word which we then render into speech.

THE advantages arising from a strict adherence to the scientific method of the alphabet, are of two kinds ; one relating immediately to the people who would thus acquire great facility in learning to read and write ; the other relating immediately to the language, which would thus become uniform and steady, and would avoid corruption.

IF a person has learned to write every vocal sound, and every articulation which his organs form for the use of speech, all which are comprised within the compass of the alphabet, he has it in his power to write any speech which he is able to pronounce. He would also write that speech precisely in the manner that every other person, who has learned the alphabet, must render it again in reading.

NOW, if a language should be thus perfectly represented in the writing, the perfection of our speech might be, in this manner, communicated among the learned of the nation, and the improvements of our speech would be dispersed with our writings, by means of the improvement of our science.

BUT if, in writing our language, any other method is pursued, which is different from the scientific analysis of our speech, and elemental characterising of our vocal sounds, there will then be no fixed relation between our writing and the pronunciation of our language ; and, in that case, no literary perfection in our education, will have any tendency to improve the language of the nation.

WITH regard to a reformation of our present method, if, on the one hand, the orthographical practice of this nation has only deviated from the truth of science in a small degree, it may be easily corrected by the exertion of literary men, when they consider the danger of such a growing evil.

NOW, that there is truly danger in the case, must appear by considering how little apprehension there is in general of this
error

error in our practice, notwithstanding the length to which it is arrived.

IF, on the other hand, our writing has departed much from the rules of just orthography, in that case, however well disposed for a reformation, it is not in the power of a few individuals, to make so great a change in the literary system of the country, as this reformation would require.

BUT if there is to be acknowledged any advantage in the alphabetical method, the very difficulty of undertaking such a reformation, affords the strongest argument for the expediency of the measure.

THIS will appear by considering, that in departing from the alphabetical rule, we lose the literary advantage of the elemental method; at the same time, we do not derive from the verbal method, then so far pursued, that benefit which the Chinese have, in compensation for their want of alphabetical orthography.

THE corruption of the Chinese orthography may naturally lead to the introduction of the alphabetical method. But the corruption of the alphabetical method, while it introduces a real difficulty and confusion into our orthography, is attended with no advantage, except perhaps the ideal pleasure of some speculative men, when in pursuit of the derivation of the language.

Phyf. Cl. Dr WALKER, Professor of Natural History, read a paper on Petrification, by EVERARDUS JOANNES THOMASSEN à THEUSSINCK, of Zwoll in Holland.

1786.
July 3.
Thomassen on
petrification.

Lit. Cl. Dr HUTTON read a continuation of his Dissertation on Written Language as a Sign of Speech. [See *supra*, June 19.]

July 17.
Dr Hutton on
written language.

Phyf.

1786.

Nov. 6.

Major Williams' experiments on congelation.

Phyf. Cl. Mr ROBISON read a Letter from Dr CHARLES HUTTON, Professor of Mathematics in the Military Academy of Woolwich, containing an Account of some Experiments on the Force of Congelation, made at Quebec in 1784 and 1785, by Major EDWARD WILLIAMS of the Royal Artillery. This letter and account are printed in this volume. [No. V. *Phyf. Cl.*]

Nov. 20.

Dr Hutton on written language.

Lit. Cl. Dr HUTTON read the remainder of his Dissertation on Written Language as a Sign of Speech. [See *supra*, June 19.]

Nov. 27.

General Meeting.

A GENERAL Meeting of the Society was held for the annual election of the Office-bearers of the Society. [See Vol. I. Appendix to the History of the Society.]

Dec. 4.

Dr Home on the comparative strength of different tonics in dyspepsia.

Phyf. Cl. Dr FRANCIS HOME read an Account of some Experiments on the comparative Strength of different Tonics in Dyspepsia.

Letter relative to the kraken.

AT the same Meeting, a Letter was read from JOHN RAMSAY L'AMY, Esq; one of the Justices of Peace for the county of Forfar, and Mr JOHN GUILD, one of the Magistrates of Dundee, inclosing an affidavit made before them, of JENS ANDERSON, master, and MADDS JENSON, mate of a Norwegian ship, relating to the appearance of a supposed kraken or sea-worm, on Sunday, August 5. 1786. about 15 leagues to the eastward of the coast of Scotland, in north latitude 56.16. The appearance was that of three low islands or sand-banks of a grayish colour, within less than a mile's distance from the ship, and extending about three miles from the one extremity to the other. It remained in sight about fifty minutes, and upon the springing up of a breeze, gradually sunk into the water. The account contains no further particulars worthy of notice, and is perfectly consistent with the idea of this being nothing more than

than a fog-bank, of which the appearances are familiar to mariners.

1786.

Lit. Cl. Mr JOHN ROBISON, General Secretary, read part of a Dissertation by the Reverend Mr WALTER YOUNG, Minister of Erskine, on Music and Poetry. The Dissertation is printed in this volume. [No. III. *Lit. Cl.*]

Dec. 18.
Mr Young on
music and poe-
try.

Phyf. Cl. THE Secretary read an Account by Dr CHARLES HUTTON of Woolwich, of some Experiments made by him to determine the Resistance of the Air to Bodies moved through it. This Account is published in this volume. [No. VI. *Phyf. Cl.*]

1787.
Jan. 1.
Dr Ch. Hutton
on the resistance
of the air.

Lit. Cl. Mr ROBISON read a continuation of the Reverend Mr YOUNG's Dissertation on Music and Poetry, printed in this volume. [No. III. *Lit. Cl.*]

Jan. 15.
Mr Young on
music and poe-
try.

A GENERAL Meeting of the Royal Society was held for the election of Members. [See List in the Appendix to Vol. I. Part I.]

Jan. 22.
General Meet-
ing.

Dr WALKER exhibited to the Meeting several specimens of natural productions and artificial rarities which had been presented to the Society in the course of the last year. These were ordered to be repositied in a proper place of the Musæum of the University, and a list was directed to be made out, and printed in the Appendix to the historical part of this volume. [See Appendix.]

Donations to
the Society.

At the same Meeting, the Secretary presented to the Society the following works: *Traité Analytique des Mouvements apparens des Corps Célestes*, par M. DIONIS de Sejour; and *Essai sur la Fluide Electrique*, par feu M. LE COMTE de Tressan; the former

Donations to
the Society.

1787.

sent to the Society by the author, the latter by M. L'ABBE TRESSAN, the author's son. The Secretary also presented from Dr BLANE his Observations on the Diseases of Seamen. These books are in the list of donations printed in Vol. I. of the Society's Transactions.

Feb. 5.

Mr Robtson on
the Georgium
Sidus.

Phyf. Cl. Mr Professor ROBISON read a Comparison of the Theory of the Motion of the New Planet, read by him last year, with some additional observations made by him since. [See Vol. I. No. XI. *Phyf. Cl.*]

Volcanic erup-
tions in Iceland.

At the same Meeting, Dr WALKER read an Extract from an Account of the Volcanic Eruptions in Iceland during the year 1783.

Feb. 19.

Mr Young on
music and poc-
try.

Lit. Cl. Mr ROBISON read the remaining part of the Reverend Mr WALTER YOUNG's Dissertation on Music and Poetry; which is printed in this volume. [No. III. *Lit. Cl.*]

March 5.

Experiments by
Dr Home.

Phyf. Cl. Dr FRANCIS HOME read an Account of some Medical Experiments made by him upon the *Digitalis*.

March 19.

Dr Beattie on
the sixth book
of the Eneid.

Lit. Cl. Mr DALZEL read a Dissertation by Dr JAMES BEATTIE, Professor of Philosophy in the Marischal College of Aberdeen, entitled, Remarks on some Passages of the sixth Book of the Eneid. This Dissertation is printed in this volume. [No. II. *Lit. Cl.*]

April 2.

Mr Wallace on
the east wind.

Phyf. Cl. GEORGE WALLACE, Esq; Advocate, read a part of a Dissertation on the Causes of the Disagreeableness and Coldness of the East Wind. The author did not incline that any abstract should be given of this Dissertation.

Lit.

1787.

April 16.

Letter from the
Teshoo Lama to
Mr Hastings.

Lit. Cl. Mr MACONCHIE communicated from ROBERT BOGLE of Daldowie, Esq; a copy of a letter, written in 1773, by the Teshoo Lama of Thibet, to WARREN HASTINGS, Esq; Governor-general of Bengal, while a brother of Mr BOGLE's was residing at the Lama's court, as envoy from Mr HASTINGS. Mr MACONCHIE remarked, that the turn of thought and expression rendered the letter a very great curiosity; but that it was still more interesting on two accounts: *first*, That it established beyond all question, that the Teshoo Lama, though a Pontiff of inferior rank to the Dalai Lama, is understood to possess the soul of saints, or divine personages that flourished in former times, and to retain the remembrance of what happened to them in those past periods of existence. *2dly*, That the same places which are regarded in Bengal as peculiarly sacred, are likewise regarded by the religion of Fo as holy; that the Teshoo Lama, in some of his former states of existence, is supposed to have resided in those places; that the Ganges, so revered among the Brahmins, is also revered by the worshippers of Fo; and that the reference by the followers of that religion in Japan, to some region in India, as the origin and holy land of their faith, is here ascertained to belong to Bengal. These circumstances, he thought, suggested very important reflections with regard to the history of the religions of Eastern Asia.

THE letter is as follows:

From TESHOO LAMA to the GOVERNOR.

Received the 22d July 1775.

“ Mr BOGLE, whom, out of your kindness, you were pleased
 “ to send into this quarter, having (thank God) arrived here in
 “ perfect health, I had, at an auspicious hour, the pleasure of an
 “ interview with him, and was rendered so completely happy on
 “ the occasion, that it might in reality have been thought an in-
 (C 2) “ terview

"terview with yourself. The letter which you addressed to me,
 "and the presents you sent by Mr BOGLE, I have likewise re-
 "ceived safe. May your happiness and prosperity daily in-
 "crease. All the particulars which Mr BOGLE verbally repre-
 "sented to me, I perfectly understand. You were pleased to
 "write me, that you had sent orders for establishing peace with
 "the Debe Doria, agreeable to my request. True; the pleasure
 "these particulars gave me, it is impossible to express. When
 "you, out of pure friendship, are induced thus readily to com-
 "ply with a request of mine, what return can I make you for
 "it, but offer you my prayers? You have laid me under an ob-
 "ligation to you for ever; and I hope that you will every where
 "prove victorious and successful. What can I say to you of my
 "own situation? In former ages, I repeatedly received my ex-
 "istence from Allahabad, Benares, Patna, Purnea, and other
 "places in Bengal and Orissa; and having ever enjoyed much
 "happiness from those places, I have imbibed a partiality for
 "them; and a sincere love and affection for their inhabitants
 "are strongly impressed on my heart. The well known place of
 "Outragund gave me my last existence; and thanks be to God,
 "the inhabitants of this quarter are all content and satisfied with
 "me. Where my spiritual essence will transmigrate to next, will
 "hereafter be seen. At present, here I sit in this icy country,
 "in obedience and subjection to the Emperor of China. I have
 "long had a desire of seeing you, and the dominions and people
 "over whom you rule; but hitherto many causes have occurred
 "to prevent me, whatever may happen in future. My travelling so
 "far as your country, to obtain a personal interview with you,
 "must, however, be attended with many unfurmountable diffi-
 "culties, and Providence has decreed that we should be at this
 "necessary distance from each other. From this consideration,
 "I am induced to request that you will grant me a piece of
 "ground near the sea-side, that I may build a house of wor-
 "ship thereupon; and for the expences of building it, I have
 "sent

“ sent an hundred pieces of gold by Mr BOGLE, together with
 “ some carpets, cloths, and other necessaries, which he will shew
 “ you, for the decoration of it ; and I request that you will do
 “ me the favour to let the house be immediately built, and the
 “ things put up ; and as soon as the cold season sets in, I will
 “ certainly dispatch to you some of my own people, if not some
 “ of the family of the Lama, who is patron of the Emperor of
 “ China. I hope that you will receive them with kindness, and
 “ send some of your own servants with them, to visit every place
 “ of worship at Allahabad, Benares, &c. for the discharge of their
 “ religious duties. As this country is under the absolute sove-
 “ reignty of the Emperor of China, who maintains an active and
 “ unrelaxed control over all its affairs ; and as the forming of any
 “ connection or friendship with foreign powers is contrary to his
 “ pleasure, it will frequently be out of my power to dispatch any
 “ messengers to you. However, it will be impossible to efface the
 “ remembrance of you out of my mind ; and I shall always pray
 “ for the increase of your happiness and prosperity, and, in re-
 “ turn, I hope you will frequently favour me with accounts of
 “ your health. To avoid troubling you, and intruding longer
 “ upon your time with my incorrect style, I shall conclude this,
 “ but beg you will favour me with an answer ; and I shall take
 “ an opportunity of addressing you by every person who goes
 “ from hence into your part of the world. I have represented all
 “ particulars to Mr BOGLE, who will communicate them to you,
 “ and I hope you will consent to them.

[On a separate paper.]

“ HAVING, in compliance with my request, put an end to
 “ hostilities with the Debe Raja, and established a peace with
 “ him, you have thereby conferred upon me the greatest obliga-
 “ tion. As a testimony whereof, I send you a present of a few
 “ things ; and, although not worth acceptance, I beg you will ac-
 “ cept

1787.

“ cept of them, merely upon this consideration, that a green leaf
“ is a present from a hermit.

“ *List of Presents.*

“ 8 pieces of China satin.

“ 1 silver talent of China.

“ 1 Pelong handkerchief.

“ I CAN make no suitable return for your friendship from this
“ part of the world, and I hope you will excuse it. POORUN
“ KER CUSHOO will have the honour of paying his respects to
“ you ; and I hope you will grant him your favour and protec-
“ tion in the business with which he is entrusted.”

June 18.

Dr Gregory on
the moods of
verbs.

Lit. Cl. Dr GREGORY read a Philological Dissertation, en-
titled, Theory of the Moods of Verbs ; which is published in
this volume. [No. IV. *Lit. Cl.*]

July 2.

Mr Wallace on
the east wind.

Phyf. Cl. Mr GEORGE WALLACE read the continuation of
his Dissertation on the Causes of the Disagreeableness and Cold-
ness of the East Wind. [See *supra*, April 2.]

Letter from the
President de
Virly.

AT the same Meeting, the following Letter from the President
de Virly, at Dijon, was read :

A Paris ce 10me Mars 1787.

On the use of
caustic alkali in
the cure of gra-
velous disorders.

“ IL fera peut être agréable à la Société d'apprendre que l'on
“ a appliqué à Dijon, avec succès un remède que l'on doit à
“ un medecin de votre isle : l'alkali caustique pris intérieure-
“ ment pour le calcul ou la pierre. M. DURANDE, medecin
“ de cette ville a eu un malade qui avoit rendu beaucoup de
“ gravier par les urines, et avoit de grandes douleurs. Le ma-
“ lade, en même tems, ne vouloit pas entendre parler de se
“ faire

1787.

“ faire fonder. M. DURANDE lui a administré l’alkali caustique dans un bouillon de veau, qui contenoit à peu près une livre d’eau. Il a commencé par dix gouttes, et a fini, en augmentant la dose, par l’administrer jusqu’à quarante gouttes. Au bout de six semaines, les accidens avoient tellement cessé que le malade a dit n’avoir plus besoin de rien. Il y a dix mois, et il se trouve très bien.

“ UN autre malade a commencé le même remède. Un verre de son urine le cinquième jour de traitement, tems auquel il prenoit douze gouttes d’alkali caustique, a été essayé. Le papier de Fernambouc s’est très légèrement altéré. L’eau chargée d’air fixe a troublé un verre de cette urine, et y a occasionné un très léger dépôt. On fait que l’eau gaseuse reprend l’alkali à la matière du calcul.

“ ON s’étoit assuré par le papier teint avec le jus de mauve que le bouillon ne dénatureroit point l’alkali caustique. Il faut avoir soin que l’alkali soit bien caustique, et n’aye pas perdu sa vertu par le contact de l’air.

“ IL s’est présenté à moi un fait en Angleterre, qui, je crois, n’a pas été encore observé. C’est une espèce de basalte artificiel. En examinant, auprès de Sheffield, des matériaux pour réparer la route, je cassai plusieurs de ces morceaux de terre cuite dont on se sert dans plusieurs endroits de l’Angleterre pour réparer les chemins. Ces morceaux se cassoient en prismes hexagones très réguliers, tels que ceux des basaltes. Les différentes personnes à qui je les ai montrés, notamment M. WATT, ne les connoissoient pas. Je n’en avois jamais vu non plus. Je vous serai obligé Monsieur, de communiquer ce fait à Monf. le Dr HUTTON, qui a fait beaucoup d’observations, dont on verra sûrement la publicité avec grand plaisir. J’ai l’honneur d’être,” &c.

Of an artificial
basaltes.

Lit. Cl. Dr GREGORY read the continuation of his Theory of the Moods of Verbs, published in this volume. [No. IV. *Lit. Cl.*]

Phys.

July 16.
Dr Gregory on
the moods of
verbs.

1787.

August 6.

New species of
cochineal.

Phys. Cl. Dr JAMES ANDERSON laid before the Society a specimen of a new species of cochineal, lately discovered on the coast of Coromandel by JAMES ANDERSON, M. D. Physician-general at Madrafs.

Count de Win-
dischgratz's
problem.

At the same Meeting, Mr Commissioner SMITH acquainted the Society, that the Count de WINDISCHGRATZ had transmitted to him three Dissertations, offered as solutions of his Problem, [See Transactions, Vol. I. Hist. of the Soc. p. 37. & 45.] and had desired the judgment of the Society upon their merits. The Society referred the consideration of these papers to Mr SMITH, Mr HENRY MACKENZIE of the Exchequer, and Mr WILLIAM CRAIG, Advocate, as a Committee to peruse and consider them, and to report their opinion to the Society at a subsequent Meeting.

Nov. 5.

Mr Lockehead on
the nat. hist. of
Madeira.

Phys. Cl. Dr WALKER, Professor of Natural History, read part of a Dissertation, written by Mr LOCHEAD, on the Natural History of Madeira.

Nov. 19.

Mr Dalzel on
the Greek Σ.

Lit. Cl. Mr DALZEL read the continuation of his Dissertation on certain Analogies observed by the Greeks in the use of their Letters; and particularly of the Letter Σ. [See *supra*, Dec. 19. 1785.]

Nov. 26.

General Meet-
ing.

A GENERAL Meeting of the Royal Society was held for the election of General Office-bearers for the ensuing year; when all those of the preceding year were re-elected.

Dec. 3.

Dr Hutton's
answers to M.
de Luc.

Phys. Cl. Dr JAMES HUTTON read Answers by him to the Objections of M. DE LUC, with regard to his Theory of Rain, (published in Transactions, Vol. I. No. II. *Phys. Cl.*) These Answers are printed in this volume. [No. VIII. *Phys. Cl.*]

Lit.

Lit. Cl. Mr DALZEL read an Essay on the Standard of Taste, and on the Nature and History of Criticism. He did not incline that this Essay, or any abstract of it, should be printed in this volume.

1787.
Dec. 17.
Mr Dalzel on
the standard of
taste.

He also read a short Essay by the Reverend Mr ROBERTSON, Minister of Dalmeny, on the Subjunctive Mode in English Verbs, and on *shall* and *will*. The author did not incline that any account of this Essay should be given in this volume.

Mr Robertson
on the subjunc-
tive mode in
English verbs.

Phys. Cl. Dr WALKER read a continuation of Mr LOCHEAD's paper on the Natural History of Madeira. [See *supra*, Nov. 5. 1787.]

1788.
Jan. 7.
Mr Lochead on
the nat. hist. of
Madeira.

Lit. Cl. Mr MACONOCHE read a paper containing Observations respecting the Country, Religion, Political Institutions, and Sciences of the Hindoos.

Jan. 21.
Mr Maconochie
on the Hindoos.

At the same Meeting, Mr Commissioner SMITH reported the opinion of the Committee appointed to examine the three Dissertations offered as Solutions of the Count de WINDISCHGRATZ's Problem, [See *supra*, Aug. 6. 1787.]; which was, That none of the three Dissertations amounted, either to a solution, or to an approximation towards a solution of that problem. The Committee, however, intimated their opinion, that one of these Dissertations, superscribed with the following sentence, *Si quid novissi rectius illis*, &c. though neither a solution of the problem nor an approximation to it, was a work of great merit. The Royal Society, hereupon, pronounced their judgment in terms of the said report; and they requested Mr FRASER TYTLER to transmit this judgment, and the opinion of the Committee, by a letter to the Count de WINDISCHGRATZ.

Report and
judgment rela-
tive to the
Count de Win-
dischgratz's
problem.

A GENERAL Meeting of the Royal Society was held for the election of Members. [See List in the Appendix to the History of the Society.]

Jan. 23.
General Meet-
ing.

1788.

Feb. 4.

Sir James Hall
on Lavoisier's
theory of che-
mistry.

Phys. Cl. Sir JAMES HALL, Baronet, read part of a paper entitled, A View of M. LAVOISIER's new Theory of Chemistry. He did not incline that this paper, or any abstract of it, should be printed in this volume.

Feb. 18.

Dr Hill on sy-
nonymous
words.

Lit. Cl. Dr JOHN HILL read part of an Essay on Synonymous Words. As this Essay forms part of a larger work, which is not yet completed, the author did not chuse that any abstract of it should be given in this volume.

March 3.

Sir James Hall
on Lavoisier's
chemistry.

Phys. Cl. Sir JAMES HALL read a second part of his paper on M. LAVOISIER's new Theory of Chemistry. [See *supra*, Feb. 4.]

Spirits distilled
from carrots.

At the same Meeting, the Secretary read a communication from Dr HUNTER and Mr HORNBY of York, respecting the Distillation of Ardent Spirits from Carrots. A specimen of the Spirits had likewise been sent to the Royal Society. The Society appointed Dr BLACK, Dr HUTTON, and Mr JAMES RUSSELL, surgeon, to examine this account, together with the specimen of the spirits, and to report upon the same.

March 17.

Biographical
account of the
Lord President
Dundas.

Lit. Cl. Mr FRASER TYTLER read a Biographical Account of the late Lord President DUNDAS; which is published in this volume. [Appendix to the History of the Society.]

Mr Ramsay on
the funeral rites
of the High-
landers.

Mr Professor FINLAYSON read a Dissertation by JOHN RAMSAY, Esq; of Auchtertyre, on the Funeral Rites of the Highlanders.

April 7.

Mr Robison on
the motion of
light.

Phys. Cl. Mr PLAYFAIR read a paper by Mr JOHN ROBISON, Professor of Natural Philosophy, on the Motion of Light, as affected by Refracting and Reflecting Substances, which are also in motion. This paper is published in this volume. [No. XI. *Phys. Cl.*]

AT

AT the same Meeting, Sir JAMES HALL read the concluding part of his View of M. LAVOISIER's Theory of Chemistry. [See *supra*, Feb. 4. and March 3. 1788.]

1788.
April 7.
Sir James Hall
on Lavoisier's
chemistry.

Lit. Cl. Mr HENRY MACKENZIE read an Account of the German Theatre, with Remarks upon Dramatic Performances in general. This paper is printed in this volume. [No. V. *Lit. Cl.*

April 21.
Mr Mackenzie
on the German
theatre.

Phyf. Cl. Dr HUTTON read a paper on Phlogiston, in answer to the Observations of Sir JAMES HALL, in his Account of M. LAVOISIER's Chemistry.

May 5.
Dr Hutton on
phlogiston.

Phyf. Cl. THE Society met this day *extra ordinem*. Dr HUTTON read some further Observations on Phlogiston; and Sir JAMES HALL read a paper in reply to Dr HUTTON's former Observations on that subject.

May 12.
Dr Hutton and
Sir James Hall
on phlogiston.

A GENERAL Meeting of the Royal Society was held for the election of Members. [See List in the Appendix to the History of the Society.]

June 23.
General Meet-
ing.

Phyf. Cl. An Account was read by Dr JAMES ANDERSON, of thirteen letters from JAMES ANDERSON, M. D. Physician at Madras, to Sir JOSEPH BANKS, F. R. S. Lond. respecting the Discovery of a new species of Cochineal. [See *supra*, Aug. 6. 1787.]

July 7.
Dr Anderson on
a new species of
cochineal.

Lit. Cl. Mr DALZEL read a Dissertation by Mr THOMAS ROBERTSON, Minister of Dalmeny, on the Character of SHAKESPEARE's HAMLET. This paper is printed in this volume. [No. VII. *Lit. Cl.*

July 21.
Mr Robertson
on the character
of Hamlet.

(D 2) *Phyf.*

1788.

Nov. 3.

Mr Small on
ventilation.

Phys. Cl. Mr DALZEL read an Essay on Ventilation, by
ALEXANDER SMALL, Esquire.

Spirits distilled
from carrots.

AT the same Meeting, a Report was presented from Dr BLACK, Dr HUTTON, and Mr RUSSELL, on Dr HUNTER and Mr HORNBY's process for producing an ardent spirit from carrots. [See *supra*, March 3. 1788.] The report is as follows :

WE have examined the sample of spirits, which was sent by Dr HUNTER of York to the Royal Society, and we have read the account of the experiment on the fermentation and distillation of carrots by which the said spirit was produced. The experiment was made by Mr THOMAS HORNBY, druggist in York, with one ton and eight stone of carrots, which, after being exposed to the air a few days to dry, weighed 160 stone, and measured 42 bushels ; they were washed, topped and tailed, by which they lost in weight 11 stone, and in measure seven bushels ; being then cut, they were boiled with the proportion of 24 gallons of water to one third of the above quantity of carrots, until the whole was reduced to a tender pulp, which was done in three hours boiling. From this pulp, the juice was easily extracted by means of a press, and 200 gallons of juice were produced from the whole. This juice was boiled again with one pound of hops five hours, and then cooled to 66 of FAHRENHEIT, and six quarts of yeast being added, it was set to ferment. The strong fermentation lasted 48 hours, during which time the heat abated to 58 of FAHRENHEIT ; 12 gallons of unfermented juice, which had been reserved, were then heated and added to the liquor, the heat of which was thus raised again to 66, and the fermentation was renewed for 24 hours more, the air of the brewhouse being all this time at 46 and 44. The liquor was now turned, and continued to work three days from the bung ; and, lastly, it was distilled, and the first distillation was rectified next day without any addition.

dition. The produce was twelve gallons, of the same quality with the sample.

1788.

IN our examination of this sample, we found it resembled a corn spirit in flavour, but was equal to a corn spirit of the best kind, and it was a proof spirit.

THE refuse of the carrots weighed 48 stone, which, added to the tops and tails, made provision for hogs, beside the wash from the still, which measured 114 gallons.

FROM this experiment, Dr HUNTER draws the following comparison between the distillation of carrots and that of grain:

20 tons of carrots, which will make 200 gallons of proof spirits, may be bought for L. 16.

8 quarters of malt, or rather the materials for distillation, consisting of malt, wheat and rye, may be bought for L. 16, and will also make 200 gallons of proof spirit.

THE refuse from the carrots will be 960 stone, which, at 1 d. *per* stone, will sell for L. 4.

THE refuse or grains from the malt, &c. will be 64 bushels, each bushel weighing about 3 stone, which, at 1 d. *per* stone, will sell for 16 s.

THE Doctor, however, supposes, that the manufacturing of the spirit from carrots may be attended with more expence than the manufacturing of it from malt; but imagines that the greater value of the refuse may compensate for that expence, and that the saving of corn for other purposes, is an object worthy of attention and of encouragement.

(Signed)

JOSEPH BLACK.

19th May 1788.

JAMES RUSSELL.

JAMES HUTTON.

Phyf. Cl. Dr WILLIAM WRIGHT, F. R. S. Lond. read a Botanical and Medical Account of the Quassia Simaruba; which is printed in this volume. [No. X. *Phyf. Cl.*]

Dec: 1.
Dr Wright on
quassia simaruba.

AT

1788.

Dec. 1.

Sir Ja. Hall on
pumice stone.

AT the same Meeting, Sir JAMES HALL read a paper on the Formation of Pumice Stone.

Mr Leslie on
the solution of
certain math.
problems.

Mr PLAYFAIR read a paper by Mr JOHN LESLIE, on the Solution of certain indeterminate Problems in Mathematics. This paper is printed in this volume. [No. XIV. *Phys. Cl.*]

Dec. 15.

Dr Hill on syn.
words.

Lit. Cl. Dr JOHN HILL read a continuation of his Essay on Synonymous Words. [See *supra*, Feb. 18. 1788.]

APPEN-

A P P E N D I X.

January 1. 1790.

LIST of MEMBERS or FELLOWS of the ROYAL SOCIETY of Edinburgh, continued from January 1. 1788. when the first Volume was published.

OMITTED by mistake in the former LIST.

- * *Robert Hamilton*, M. D. Fellow of the Royal College of Physicians, and Physician at Lynn Regis, in Norfolk. P.

THE following were elected at the General Meeting, Jan. 28. 1788.

Members chosen, Jan. 28. 1788.

I. RESIDENT.

Mr *Robert Ker*, Surgeon in Edinburgh. P.

2. NON-RESIDENT.

William Hamilton, M. A. Fellow of Trinity College, Dublin. L.

Robert Adam, Esq; Architect to King GEORGE III. and Queen

CHARLOTTE, F. R. S. & S. A. Lond. &c. L.

Caleb Whiteford, Esq; Lond. L.

Major-general *William Roy*, F. R. S. Lond. P.

George Dempster, Esq; of Dunnichen. L.

Charles Thomas Hope, M. D. Professor of Medicine in the University of Glasgow. P.

Mr

Mr *John Rennie*, Engineer, London. *P.*

Lieutenant *Robert Arbuthnot*. *L.*

3. FOREIGN.

M. L'Abbé *Raynal*.

Members chosen, June 23, 1788.

THE following were elected at the General Meeting, June 23, 1788.

1. RESIDENT.

Thomas Spens, M. D. Edinburgh. *P.*

Lewis Alexander Grant, Esq; of Grant, Advocate. *L.*

David Smyth, Esq; of Methven. *L.*

Charles Hope, Esq; Advocate. *L.*

John Wilde, Esq; Advocate. *L.*

The Reverend Mr *William Moodie*, Minister of St Andrew's Church, Edinburgh. *L.*

2. NON-RESIDENT:

Robert Clegborn, M. D. Glasgow. *P.*

Robert Bogle, Esq; of Daldowie. *L.*

William Lister, M. D. Lond.

Members chosen, Jan. 26, 1789.

THE following were elected at the General Meeting, Jan. 26, 1789.

1. NON-RESIDENT.

Bartholomew Parr, M. D. of Exeter. *P.*

John Drummond, M. D. of Jamaica. *P.*

John Ogilvy, D. D. Minister at Midmar. *L.*

General *Robert Melvil*. *L.*

2. Fo-

2. FOREIGN.

M. Guyot, of Paris.

Mr Jefferson, Minister Plenipotentiary from the States of America, at Paris.

THE following were elected at the General Meeting, June 29. 1789.

Members chosen, June 29. 1789.

I. NON-RESIDENT.

John Thomas Stanley, Esq; of Alderley in Cheshire, F. A. S. Lond.

2. FOREIGN.

Henry Engelbart, M. D. Professor of the Practice of Physic in the University of Lunden.

Joachim Ramm, M. D. of Riga.

OFFICE-BEARERS of the SOCIETY.

General office-
bearers.

OFFICE-BEARERS elected for the ensuing year, at the General Meeting held for that purpose, Nov. 30. 1789.

President.

His Grace the Duke of BUCCLEUGH.

Vice-Presidents.

Right Hon. *Henry Dundas.* | *Lord Dunfinnan.*

Secretary.

Treasurer.

Mr *John Robison.*| Mr *Alex. Keith.*

Counfellors.

Dr *James Hutton.*| Lord *Elliock.*Mr *Geo. Fergusson.*| Major-Gen. *Fletcher-Campbell.*Mr *Benjamin Bell.*| Mr Commissioner *Edgar.*Mr *Dugald Stewart.*| Sir *William Miller, Bart.*Dr *Daniel Rutherford.*| Dr *Adam Ferguson.*Dr *James Gregory.*| Lord *Dreghorn.*

OFFICE-

OFFICE-BEARERS of the two CLASSES.

Office-bearers
of the classes.

PHYSICAL CLASS.

Presidents.

Dr <i>William Cullen.</i>		Dr <i>Alexander Monro.</i>
Dr <i>Francis Home.</i>		Dr <i>Joseph Black.</i>

Secretaries.

Dr <i>John Walker.</i>		Mr <i>John Playfair</i> *.
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LITERARY CLASS.

Presidents.

Mr Baron <i>Gordon.</i>		Dr <i>William Robertson.</i>
Mr Commissioner <i>Smith.</i>		Dr <i>Hugh Blair.</i>

Secretaries.

Mr <i>Alex. Fraser Tytler.</i>		Mr <i>Andrew Dalzel.</i>
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* Who had also been elected at the General Meeting, June 29. 1789, on the resignation of Dr *Gregory.*

LIST of MEMBERS deceased, continued from the first volume.

Hary Spens, D. D. Professor of Divinity in the University of St Andrew's. November 27. 1787.

The Right Hon. *Robert Dundas* of Arncliffe, Lord President of the Court of Session. December 13. 1787.

John Drysdale, D. D. one of the Ministers of Edinburgh, Dean of the Chapel Royal, and Principal Clerk to the Church of Scotland. June 16. 1788.

John Macfarlan, D. D. Minister of Canongate, and Almoner to his Majesty. December 24. 1788.

The Reverend Mr *John Logan*, formerly one of the Ministers of Leith. December 28. 1788.

The Right Hon. Sir *Thomas Miller*, of Glenlee, Baronet, Lord President of the Court of Session. September 27. 1789.

FOREIGN MEMBERS deceased.

M. le Comte de *Buffon*. April 16. 1788.

Petrus Camper, M. D. Holland. 1789.

SINCE the publication of the preceding volume, the following BIOGRAPHICAL ACCOUNTS have been read at different Meetings of the Classes.

I. Ac-

I. ACCOUNT of the Right Honourable ROBERT DUNDAS of Arniston, Lord President of the Court of Session in Scotland, F. R. S. EDIN. &c.

[Read by ALEX. FRASER TITLER, Esq; Advocate, March 17. 1788.]

ROBERT DUNDAS of Arniston, late Lord President of the Court of Session, was the descendant of a family to which the historian and genealogist have assigned an origin of high antiquity and splendor *, but which has been still more remarkable for producing a series of men, eminently distinguished for their public services in the highest civil offices of this country. If the pride of ancestry is ever allowable, it is where those ancestors have adorned the stations which they filled, by that genuine merit which, independently of rank, must have entitled them to the respect and esteem of their fellow-citizens. Such were the progenitors of the late Lord President, whose family has produced a succession of men, who, for four generations, have discharged the highest offices of the law in this country with equal abilities and integrity.

As the merits of some of these eminent persons entitle them to more than general eulogy, and as there are some circumstances of their lives and characters too honourable, and indeed too exemplary to be passed over in silence, I shall here mention

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* Sir JAMES DUNDAS, first Baron of Arniston, Governor of Berwick, and knighted by King JAMES VI. was the third son of GEORGE DUNDAS of Dundas, (by CATHERINE, daughter of LAURENCE Lord Oliphant) the sixteenth in descent from the DUNBARS Earls of March, who, according to Sir JA. DALRYMPLE, CRAWFORD, NISBET, &c. derive their origin from the Saxon Kings of England.

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a few anecdotes respecting them, as introductory to the account of *His* life, on whom I mean more particularly to enlarge.

Sir JAMES DUNDAS of Arncliffe, eldest son of Sir JAMES DUNDAS, Governor of Berwick, by MARY, the daughter of GEORGE HOME of Wedderburn, had the honour of knighthood conferred on him by CHARLES I. In the earlier part of his life, and in the course of a very liberal education, he had spent a considerable time abroad, and visited the politest of the foreign Courts. On his return to his native country, he was chosen Representative of the county of Edinburgh in the Scottish Parliament; and, in the most difficult of times, when public virtue was put to the severest trials, uniformly maintained the character of a steady and sincere patriot. He disapproved, as did many of the best friends of their King and Country, of those violent measures by which CHARLES, misguided by LAUD, endeavoured to force this kingdom to submit to the Episcopal hierarchy. The ecclesiastical and the civil liberties of the kingdom were justly regarded as most intimately connected with each other. The Church of Scotland, in all periods of its history, whatever had been its form of government and discipline, had uniformly rejected the idea of dependence on the Metropolitan sees of England*; and at this time, even those among the Scots who approved of the Episcopal forms, could not brook that rules of discipline should be prescribed to them by English ecclesiastics. They were justly indignant at those measures which they considered as a tyrannical endeavour to bring the National Church, hitherto independent, under a dishonourable subjection to that of England; and they regarded the attempt to introduce an English liturgy, as preparatory to the introduction of English laws. This was the idea which prevailed with many virtuous men to sign the *National Covenant*,
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* The contest for the independency of the National Church of Scotland had begun as early as the reign of ALEXANDER I.

which, by presenting a deliberate and a powerful opposition to that attack against their religious and civil liberties, bad fair to prevail with the Sovereign to abandon those unconstitutional attempts, and thus might have been the means of preserving the peace of the kingdom. In this idea, Sir JAMES DUNDAS, with many other sincere and virtuous patriots, signed the Covenant; though they saw afterwards, with regret, that the same association, which, with the well disposed, might have been an instrument of peace, was converted into an engine of tumult and sedition.

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ON the extinction of the monarchical government, the supreme court of judicature in Scotland, the Court of Session, was converted by OLIVER CROMWELL into a *Commission for the administration of justice*, and partly supplied by English Judges. Upon the Restoration, that Court resumed its ancient form; and among the new Judges appointed by the Sovereign, was Sir JAMES DUNDAS of Arncliffe, whose high character, in point of probity and natural abilities, was such as to balance the want of an education to the law as a profession. He was appointed a Judge of the Court of Session in 1662.

IN the end of the same year, CHARLES II. apprehensive of that spirit of disaffection to the government, which very generally prevailed in this country, found it necessary, with the advice of Parliament, to require all persons holding offices in Scotland, to subscribe a *Declaration*, importing that they held it unlawful to enter into Leagues and Covenants on pretence of reformation, or to take up arms against the king; and, in particular, abjuring those bonds entitled the *National* and the *Solemn League and Covenant* as illegal and seditious associations.

THIS measure was complied with by some from principle, and by others from policy. The Chancellor of Scotland being directed to require the Judges of the Court of Session to subscribe the *Declaration*, under the penalty of losing their offices, most of these,—it is to be presumed, from Conscience,—manifested

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an easy compliance. Others, however, from the same honourable motive, refused to renounce those obligations, of which, though they regretted the abuse, they approved of the principle. Among that number was Sir JAMES DUNDAS, who refused to sign the Test-declaration, unless with a subjoined clause, importing his abjuration of the Covenant, "in so far as it had led to deeds of actual rebellion." This qualified compliance was rejected by the Sovereign, and the recusant Judges were deprived of their offices. Their seats, however, were kept vacant for some time, in expectation, either that their scruples might be relaxed by the sense of their substantial losses, or that some medium of accommodation might be devised for adjusting the subject of difference. One expedient was proposed, which, it is probable, originated from the Sovereign himself, as it favours remarkably of his code of easy morality. This was, that such of the Judges as scrupled to give an unlimited declaration, should, for the sake of example, subscribe *simply*, as the law required, but should be allowed, in a private conversation with the King, to explain the sense in which they understood those oaths.

ON these singular terms, some of the deprived Judges were willing to redeem their offices. They repaired to London, had a private audience of his Majesty, and returned with new commissions in their pockets *. But that conciliatory measure was proposed in vain to Lord ARNISTON. He adhered resolutely and inflexibly to those principles which he esteemed right. To the solicitation of a friend, who earnestly intreated him, for his own sake, for that of his family and of the public, to be satisfied

* THEY would justify their conduct by the prudent reasoning which CICERO used to LENTULUS. "Nam neque pugnandum contra tantas opes, neque delendum, etiam si id fieri posset, summorum civium principatum, neque permanendum in una sententia, "conversis rebus, ac bonorum voluntatibus immutatis; sed temporibus assentiendum." Cic. *Epist. ad fam. l. 1. ep. 9.*

fied with the proposed expedient, he returned this memorable answer: "I have repeatedly told you that in this affair I have acted from conscience. I will never subscribe that declaration, unless I am allowed to qualify it; and if my *subscription* is to be *public*, I cannot be satisfied that the *salvo* should be *latent*."

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HIS seat in the Court of Session was not filled up for three years; during all which time, he was assailed in vain by the solicitations both of his brethren on the Bench, and of the King's Ministers. Happy in the approbation of his own mind, and honoured with the esteem of all men of worth, he retired to his family-seat of Arncliffe; and there, in the tranquil enjoyments of the country, in the gratification of a taste for polite literature, and in the society of his friends, he passed the remainder of his days.

Sir JAMES DUNDAS died in the year 1679. ROBERT, his eldest son, by MARION, daughter of ROBERT Lord Boyd, was bred to the profession of the law. He represented the county of Edinburgh for many years in the Parliament of Scotland; and was appointed a Judge of the Court of Session by King WILLIAM in 1689. He filled that station, during the period of thirty-seven years, with great honour and integrity; and before his death in 1727, had the satisfaction of seeing his eldest son * successively discharging the most important offices in the law, and though a very young man, far advanced in that splendid career in which he was destined to arrive at the summit of his profession.

THIS was ROBERT DUNDAS of Arncliffe, afterwards Lord President of the Court of Session, the Father of him who is the proper subject of this Memoir. Though in no period of his life distinguished for laborious application to study, he had, in

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his

* Born 9th December 1685. His mother was MARGARET, daughter of Sir ROBERT SINCLAIR of Stevenston.

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his earlier years, improved his mind by an acquaintance with general literature ; and he gained by practice, aided by uncommon acuteness of talents, a profound knowledge of the law.

He had been but eight years at the bar, when his reputation pointed him out as the fittest person to hold the office of Solicitor-general, to which he was appointed by King GEORGE I. in 1717. The state of the country, recently the scene of rebellion, and still secretly fermenting with the rancour of party-contentions, was such, as to require, on the part of the law-officers of the Crown, the utmost extent of political prudence ; a zeal firm and fervent in its aim, but cautious in its exertions, and a humane moderation in the exercise of authority, which has ever been found more efficacious than severity, in extinguishing disaffection to government.

THE office of Solicitor-general was preparatory to that of Lord Advocate for Scotland, to which Mr DUNDAS was appointed in 1720. In 1722, he was elected Member of Parliament for the county of Edinburgh ; and, in that situation, he distinguished himself by a most vigilant attention to all public measures, in which the interest of his country was concerned, and by a steady and patriotic regard for its interests.

On the change of Ministry, which took place in 1725, when Sir ROBERT WALPOLE and the Argyle party came into power, Mr DUNDAS was removed from his office of King's Advocate, and resumed his station without the bar, distinguished only by the honourable title of Dean of the Faculty of Advocates, till he was raised to the Bench in 1737. For nine years, he filled the seat of an ordinary Judge of the Court of Session, till the year 1748, when, on the death of Mr DUNCAN FORBES of Culloden, he was appointed to succeed him in the honourable and important office of President of the Court.

WHILE a barrister, he shone equally as a powerful pleader and an ingenious reasoner. To the quickest apprehension, he joined an uncommon solidity of judgment ; and embracing in
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his mind all the possible arguments which were applicable to his cause, he could, even in his unpremeditated pleadings, discover at once, and instantly attach himself to some strong principle of law on which he built the whole of his reasoning. His eloquence, though as various as the nature of the cause required, was constantly subservient to his judgment; and though master of all the powers of expression, he rarely indulged himself in what is properly termed declamation. A fine specimen of his argumentative powers is to be found in the defence for CARNEGIE of Finhaven, on his indictment for the murder of the Earl of Strathmore. In that memorable trial, he had not only the merit of saving the life of the prisoner, but of establishing a point of the utmost consequence to the security of life and liberty, the power of a jury, at that time questioned in this country, of returning a *General Verdict* on the guilt or innocence of the person accused.

IN Scotland, though *General Verdicts* appear to have been authorised by the most ancient practice of the criminal court, it had long been customary to consider jurymen as tied down to determine simply, whether the facts in the libel were *proved* or *not proved*. This change from the ancient practice is supposed, with much reason, to have been introduced into this country in the latter part of the reign of CHARLES II. ; at a time when we find the King's Advocate strenuously contending, in his *System of Criminal Law*, for the entire abolition of juries*. The latter was too strong a measure, and would have been found of difficult accomplishment; the former was of easier attainment, and answered nearly the same end. The accused person, to satisfy appearances, and for the shew of justice, was still to be tried by his peers; but his guilt or innocence was rarely within their cognisance: that was decided by the laws, or by their interpreters, the Judges; and the jury, tied down to determine solely on the proof of facts, was compelled to surrender into the hands

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* MACKENZIE Crim. Law of Scotland, tit. 23.

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of these Judges, and thus often to sacrifice the life of a fellow-citizen, though convinced of his innocence, and earnestly desirous of his acquittal.

THUS matters stood till the celebrated trial of CARNEGIE of Finhaven, who, had the powers of a Scottish jury remained thus circumscribed, must have suffered the punishment due to the foulest malefactor, for an act on which it is scarcely possible to affix a taint of blame *. The Court had found the facts in the indictment *relevant to infer the pains of law*. The proof of those facts was as clear as noon-day. There remained no hope for the prisoner, unless the jury should be roused to assert a right which they had long relinquished, and vindicate the privilege of deciding on the guilt or innocence of the accused. And this great point was gained by the powerful eloquence of the prisoner's counsel. The jury found the prisoner *Not Guilty*. From that time, the right of a Scottish jury to return a *General Verdict*, is acknowledged to be of the very essence of that institution.—And God forbid ! a period should ever arrive, when that most valuable of rights shall again be called in question.

As a Judge, Lord ARNISTON distinguished himself no less by the vigour of his talents, and his knowledge of the laws, than by his strict principles of honour and inflexible integrity. His own idea of the character, both of a Lawyer and of a Judge, remains, penned by himself, in that admirable eulogium on Lord NEWHALL, which stands upon the records of the Faculty of Advocates ; and those who yet remember the man of whom we now speak, know that many of those various

* JAMES CARNEGIE of Finhaven, was tried before the Court of Justiciary in Scotland, for the murder of CHARLES Earl of Strathmore, in 1728. At a meeting in the country, where the company had drank to intoxication, CARNEGIE of Finhaven having received the most abusive language, and sustained a personal outrage of the grossest nature, from LYON of Bridgeton, drew his sword, and staggering forward to make a pass at Bridgeton, killed the Earl of Strathmore, a person for whom he had the highest regard and esteem, and who unfortunately came between him and his antagonist, apparently in the view of separating them.

ous talents and accomplishments which he there applied to another, were in a peculiar manner his own.

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THIS eminent and truly respectable man, after a life devoted to the public good, died in the 68th year of his age, on the 26th day of August 1753.

HE left by his first wife, ELIZABETH, the daughter of ROBERT WATSON, Esq; of Muirhouse, a son, ROBERT, the late President of the Court of Session, and two daughters. By his second wife, ANNE, the daughter of Sir ROBERT GORDON of Invergordon, Baronet, he left five sons and a daughter. Of this last marriage, is the Right Hon. HENRY DUNDAS of Melville, Treasurer of the Navy; whose various and splendid abilities, directed at first to the profession of the law, and eminently displayed while he held the offices of Solicitor-general and Lord Advocate for Scotland, are now equally distinguished in the Legislative Assembly, and in the Councils of his Sovereign.

ROBERT DUNDAS of Arncliffe, late Lord President of the Court of Session, was born on the 18th of July 1713. He received the earlier parts of his education under a domestic tutor, and afterwards pursued the usual course of academical studies in the University of Edinburgh. In the end of the year 1733, he went to Utrecht, where the lectures on the Roman Law were at that time in considerable reputation. He remained abroad for four years; and, during the recess of study at the University, he spent a considerable time at Paris, and in visiting several of the principal towns of France and the Low Countries.

RETURNING to Scotland in 1737, he was called to the bar in the beginning of the following year; and, in his earliest public appearances, gave ample proof of his inheriting, in their utmost extent, the abilities and genius of his family. His eloquence was copious and animated; in argument, he displayed a wonderful fertility of invention, tempered by a discriminating judgment,

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judgment, which gave, even to his unpremeditated harangues, a methodical arrangement; in consultation, he possessed a quickness of apprehension beyond all example; and his memory, which was most singularly tenacious, enabled him to treasure up, and to produce instantaneously, every case or precedent which was applicable to the matter before him.

THUS liberally endowed by nature with every requisite to eminence in his profession, he had the honour of being appointed Solicitor-general for Scotland in September 1742, at the early age of twenty-nine. This important office he held only for four years. He had obtained it through the favour of the Carteret administration, which was then in power; but, on the change of Ministry, which took place in 1746, when the Pelham party regained its influence in the Cabinet, he, together with the other friends of the former Ministry, resigned their offices.

BUT the high consideration in which he then stood with his brethren at the bar, was not diminished by the loss of an office dependent on ministerial favour. In the same year, 1746, he was elected Dean of the Faculty of Advocates, and continued to preside over that respectable body till his elevation to the Bench in 1760.

IN the beginning of the year 1754, Mr DUNDAS was elected Member of Parliament for the county of Edinburgh; and, in the following summer, he was appointed his Majesty's Advocate for Scotland.

IN Parliament, the share which Mr DUNDAS took in public business, and his appearances on many interesting subjects of discussion, which occurred in that important period during which he sat in the House of Commons, were such as fully to justify the character he had already attained for talents and ability. Such was the complexion of the times, and so high the tide of party, that it was perhaps impossible for human wisdom to have pointed out a line of political conduct which
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could entirely exempt from censure. The Lord Advocate shared with the rest of his party in the censure of those who followed an opposite plan of politics; but of him it may certainly with truth be affirmed, that in no instance was he ever known to swerve from his principles, or to act a part in which he had not the countenance of many of the firmest friends to the interest of their country.

THE opposition which the Lord Advocate gave to the establishment of a *Militia* in Scotland, afforded a topic of blame to a great party in this country who warmly supported that measure. But when the question is dispassionately viewed, it will appear to be one of those doubtful points, on which the wisest men and the best patriots may entertain opposite opinions.

THE apprehension of an invasion from France, which, from the commencement of the war in 1756, had been repeatedly threatened upon the southern coasts of the island, occasioned the passing of various acts of the Legislature, for the establishment and regulation of the militia forces through the several counties of England. In the beginning of the year 1760, the same apprehension had extended to Scotland. The small armament under THUROT committing acts of depredation on the western coasts with perfect impunity, began to excite a very alarming sense of the defenceless situation of the country. Meetings were held in many of the counties, and resolutions passed for applying to Parliament to procure the establishment of a militia in Scotland, upon a similar plan with that which now subsisted in England. The political emergency appeared the same through the whole kingdom. The Scots were alike sensible to the danger of their lives and properties as their neighbours of the south. They justly considered themselves as standing, by the *Treaty of Union*, on an equal footing with the English, with regard to all the privileges of British subjects; and while the inhabitants of one part of the island were furnished
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with arms for their own defence, it seemed but justice to allow the other the same means of security and protection.

THESE arguments, which are of a general nature, or at best applicable only to a temporary emergency, and to an apprehension rather of eventual than of immediate danger, were answered by reasons drawn from the state of the country, from the character of the people, and from a view of those consequences which must have been the certain result of the proposed establishment. Scotland, it was argued, is far behind her sister-kingdom in the æconomical arts of industry. The genius of the people, particularly in the northern parts, is averse to labour and to all the arts of peace. But the Scots are warlike from constitution, and the military character of the nation has been high in all ages. The artificial habits of discipline and regular exercise, are little necessary in a country, where men are by nature soldiers, attached with enthusiasm to their native land, and prompt to defend themselves with spirit upon the slightest alarm of danger. But they need excitement to the arts of industry. Agriculture is, in many districts, shamefully neglected. Manufactures, through the whole country, are yet in their infancy. The employment of our labourers can neither be spared from their fields, nor of our mechanics from their looms, their forges, or their anvils. To offer to those who are naturally little disposed to industry, such allurements to idleness as a national militia would present, would be, in the highest degree, impolitic and ruinous to the country.

THUS, it appears, that the scheme for the establishment of a militia in Scotland, admits of very opposite views; and men of candour, equally endowed with good sense, and equally patriotic, may be supposed, as was certainly the case, to have formed different opinions on the subject. What part the Lord Advocate of Scotland, who, by his office, is one of the chief guardians of the state, and bound by duty to a watchful attention in all matters which regard the interest of his country, ought

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to have taken in that measure, it would be presumption in any man to pronounce with confidence, while he must admit, that opinions, equally weighty and respectable, are found on either side of the question.

It is not to be denied, that arguments of a very illiberal nature were urged in Parliament by a few Members, who, with a mean and narrow spirit, reproached this country with disaffection to Government, and inculcated the danger of allowing the use of arms to those who had recently employed them in rebellion. It was no wonder that aspersions of this nature called forth the most animated, noble and spirited defence of their country's honour from several of the Scottish Members, who perhaps contended the more keenly in behalf of that measure, that they saw it opposed from such unworthy motives. But the question, viewed without prejudice, remains still disputable; and the arguments of the Lord Advocate against the establishment of a militia in Scotland, were founded on the great principles of national expediency, and a regard for what appeared to him the real and substantial interests of the country.

ON the 14th of June 1760, Mr DUNDAS was appointed President of the Court of Session. This was the æra of the splendour of his public character. Invested with one of the most important trusts that can be committed to a subject, the superintendence and regulation of the highest judicature of his country, he acquitted himself of that trust, during the twenty-seven years in which he held it, with such consummate ability, wisdom and rectitude, as must found a reputation as durable as the national annals, and transmit his memory with honour to all future times.

AT his first entry upon office, the public, though well assured of his abilities, was doubtful whether he possessed that power of application and measure of assiduity, which is the first duty

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of the station that he now filled. Fond of social intercourse, and of late engaged in a sphere of life where natural talents are the chief requisite to eminence, he had hitherto submitted but reluctantly to the habits of professional industry. But it was soon seen, that accidental circumstances alone had prevented the development of one great feature of his character, a capacity of profound application to business. He had no sooner taken his seat as President of the Session, than he devoted himself to the duties of his office, with an ardour of which that Court, even under the ablest of his predecessors, had seen no example, and a perseverance of attention which suffered no remission to the latest hour of his life.

Of all the grievances to which a free people can be subjected, one of the heaviest and most severe is the tediousness of judicial procedure, that delay of justice which makes often oppression itself more tolerable than the means to be pursued for obtaining its redress. Sensible of this truth, and determined to remedy (in as far as material justice would permit) so great an evil, the President applied himself immediately to the determination of a long arrear of law-suits, which, though in their last stage, and ripe for judgment, had hung upon the rolls of the Court during the period of five preceding sessions. These, in the course of the summer-session 1760, and in the first month of the next session, were all decided, while the current business of the term was likewise dispatched; and thus a load, which had been accumulating during two years and a half, was cleared away in the space of three months. The *Long Roll*, which had never been purged since the institution of the Court, and of which the very name was of evil augury, was thus annihilated at once; nor was it ever revived while Mr DUNDAS sat in the President's chair.

THE primary cause of this great reform in the dispatch of business, is certainly to be found in the uncommon power of
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his own mental abilities. Amidst that multiplicity of suits with which the Court of Session is at times overwhelmed, no party was ever heard to complain that the President had treated his cause superficially, or with an imperfect intelligence of the arguments which supported it. But the truth was, he often drew his knowledge of those arguments, less from the information of the counsel than from the storehouse of his own mind ; for it was peculiar to him, that he could make himself thoroughly master of a cause, and form the soundest judgment of its merits, from the simple perusal of the state of facts. His memory enabling him to retain these facts with the utmost ease, he could, in the course of a very few hours, dedicated to the perusal of the cases, prepare himself upon the daily business of the Court. Stimulated by his example, the other Judges exerted all their powers of application ; and thus the machine of justice moved with a constant and equal celerity, while his regulating influence operated on all its parts.

BUT if the assiduity and diligence of Judges in studying the causes that come before them, is the first requisite towards the dispatch of business, the next essential concern is, that these causes shall be decided with brevity, and that the time which is appropriated to giving judgment be not consumed in superfluous reasonings, or that species of wavering debate, which equally retards procedure, and diminishes the respect and dignity of the Court. There is no doubt that the reasoning of Judges upon the Bench, is of excellent effect, when seasoned by that discretion which is fitted to impress an audience with reverence for the wisdom and solemnity of the tribunal. And of this we have daily examples in the Supreme Court of this country. The arguments of the Judges are often replete with instruction to the bar. In many cases, to which, from their circumstantiate nature, neither the written nor the consuetudinary law is directly applicable, these are the *Responsa Prudentum* which supply

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ply that unavoidable deficiency. They are, moreover, a criterion to the public, both of the abilities of Judges, and of their attention to the duties of their office. But still, it must be admitted, that there is much danger in allowing too great latitude to judicial reasonings. Besides the delay of business, there is a hazard that that warmth of argument, against which even the wisest and most dispassionate of men cannot at all times guard themselves, should diminish the reverence due to the Court, and even the authority of its decisions; for those judgments can assuredly have but little weight which are known to be the result of a war of contradictory ideas. In a tribunal composed of many Judges, there must of course be a frequent diversity of opinion; but it is not always desirable that the grounds of those different opinions should be publicly canvassed. It is with the wisdom of a Court, as it is with personal beauty, (the observation of one of the ablest judges of human nature*) the form upon the whole, when surveyed at its proper distance, may be consummately graceful; but it is not expedient to examine it by too near an approach, or to analyse too minutely its particular features.

SUCH were known to be the sentiments of that great Judge, whose character we are now attempting to delineate; and corresponding to these sentiments was his own conduct upon the Bench. He very rarely entered into a laboured argument on the whole grounds of a cause; much less into an examination or confutation of the opinions delivered by his brethren. He limited himself to a short and solemn enunciation of his own opinion, which he generally supported by a very few reasons, on which he apprehended the decision ought to rest. His manner of speaking was firm and authoritative; his language forcible, though unadorned in its structure; and, seeking not to please, but to convince, he disregarded those graces of elocution

* CLARENDON.

tion which the orator may frequently find of use to palliate error, but which the Judge needs seldom to employ, who is desirous only of inculcating truth.

HE maintained, with great strictness, all the forms of the Court in the conduct of business. These he wisely considered as essential, both to the equal administration of justice, and as the outworks which guard the law against those too common, but most unworthy artifices which are employed to prostitute and abuse it.

To the bar, he conducted himself with uniform attention and respect. He listened with patience to the reasonings of the Counsel. He never anticipated the arguments of the pleader, nor interrupted him with questions to shew his own acuteness; but left every man to state his cause in his own way: nor did he ever interfere, unless to restrain what was either manifestly foreign to the subject, or what wounded, in his apprehension, the dignity of the Court. In this last respect he was most laudably punctilious. He never suffered an improper word to escape, either from the tongue or pen of a counsel, without the severest animadversion; and so acute was that feeling which he was known to possess of the respect that was due to the Bench, that there were but few occasions when it became necessary for him to express it.

THERE were indeed other occasions, on which his feelings were most keenly awakened, and on which he gave vent to a becoming spirit of indignation. He treated with the greatest severity every instance, either of malversation in the officers of the law, or of chicanery in the inferior practitioners of the Court. No calumnious or iniquitous prosecution, no attempt to pervert the forms of law to the purposes of oppression, ever eluded his penetration, or escaped his just resentment.

THUS, perpetually watchful, and earnestly solicitous to maintain both the dignity and the rectitude of that Supreme Tribunal
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over which he presided, the influence of these endeavours extended itself to every inferior court of judicature; as the motion of the heart is felt in the remotest artery. In reviewing the sentences of inferior judges, he constantly expressed his desire of supporting the just authority of every rank and order of Magistrates; but these were taught, at the same time, to walk with circumspection, to guard their conduct with the most scrupulous exactness, and to dread the slightest deviation from the narrow path of their duty.

WITH these endowments of mind, and high sense of the duties of his office, it is not surprising, that amidst all the differences of sentiment which the jarring interests of individuals, or the more powerful influence of political faction, give rise to, there should be but one opinion of the character of this eminent man, which is, That from the period of the institution of that Court over which he presided, however conspicuous in particular departments might have been the merit of some of his predecessors, no man ever occupied the President's chair, who combined in himself so many of the essential requisites for the discharge of that important office.

BUT it is not the intention of the writer of this account to present a faultless picture. Nothing, in fact, is of so little value as indiscriminate panegyric; nothing so empty and insignificant as *his* praise who shews that he is blind to imperfections. If we allow the merits of this great man, in possessing, in their utmost extent, the most essential requisites for the station which he filled, it is but a small derogation from the confessed eminence of his character, when we acknowledge a deficiency in some subordinate qualities.

OF these, what was chiefly to be regretted, and was alone wanting to the perfection of his mental accomplishments, was, that he appeared to give too little weight or value to those studies

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dies which are properly termed literary. This was the more remarkable in him, that, in the early period of his life, he had prosecuted himself those studies with advantage and success. In his youth, he had made great proficiency in classical learning; and his memory retaining faithfully, whatever he had once acquired, it was not unusual with him, even in his speeches on the Bench, to cite, and to apply with much propriety the most striking passages of the ancient authors. But for these studies, though qualified to succeed in them, it does not appear that he ever possessed a strong bent or inclination. If he ever felt it, the weightier duties of active life, which he was early called to exercise, precluded the opportunity of frequently indulging it; and perhaps even a knowledge of the fascinating power of those pursuits, in alienating the mind from the severer, but more necessary occupations, might have inclined him at last to disrelish from habit, what it had taught him at first to resist from principle.

THAT this principle was erroneous, it is unnecessary to consume time in proving. It is sufficient to say, that as jurisprudence can never hope for any material advancement as a science, if separated from the spirit of philosophy, so that spirit cannot exist, independent of the cultivation of literature.

THAT the studies of polite literature, and an acquaintance with the principles of general erudition, while they improve the science, add lustre and dignity to the *profession* of the law, cannot be denied. So thought all the greatest lawyers of antiquity. So thought, among the moderns, that able Judge and most accomplished man, of whose character we have traced some imperfect features, Lord Arncliffe, the Father of the late Lord President; of which his inaugural oration, as it stands upon the records of the Faculty of Advocates, bears ample testimony*.

HIS

* " FROM his first entry into the Faculty, he could say he knew, and observed it with pleasure, as it tended greatly to their honour, that there was no science, or part of polite
" lite

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HIS son, it is true, afforded a strong proof, that the force of natural talents alone may conduct to eminence and celebrity. He was rich in native genius, and therefore felt not the want of acquired endowments. But in this he left an example to be admired, not imitated. Few inherit from nature equal powers with his; and even of himself it must be allowed, that if he was a Great Man without the aids of general literature, or of cultivated taste, he must have been still a greater, had he availed himself of those lights which they furnish, and that improvement which they bestow.

THIS most useful and valuable life was terminated on the 13th of December 1787. His last illness, which, though of short continuance, was violent in its nature, he bore with the greatest magnanimity. He died in the 75th year of his age, in the perfect enjoyment of all his faculties; at a time, when his long services might have justly entitled him to ease and repose, but which the strong sense of his duty would not permit him to seek while his power of usefulness continued; at that period, in short, when a wise man would wish to finish his course; too soon indeed for the public good, but not too late for his own reputation.

HE left by his first wife, HENRIETTA BAILLIE, the daughter of Sir JAMES CARMICHAEL-BAILLIE of Lamington, four daughters.

“ lite and useful learning, for the knowledge of which some in the Faculty were not distinguished, perhaps equally with those who made the several parts of those sciences their principal and particular profession. And he hoped he would be excused for recommending to them, and to all young gentlemen that might afterwards enter among them, to be at pains to maintain and preserve that character and reputation they had long held, and still possessed, not only for the knowledge of the Civil or Roman and Municipal Laws, and the constitution of their country, but of the other valuable branches of learning, that are requisite to accomplish and adorn the character of gentlemen, and were indeed necessary to render them completely qualified for the exercise of their profession.” *Records of the Fac. of Adv.* Nov. 3. 1748.

daughters. By his second wife, JANE, the daughter of WILLIAM GRANT, Esq; of Prestongrange, one of the Senators of the College of Justice, he left four sons and two daughters. Of these, the eldest son is ROBERT DUNDAS, Esq; now of Arncliffe, his Majesty's Solicitor-general for Scotland*; whom his country sees with pleasure the heir of the abilities of his family, already high in the esteem of all his cotemporaries, and pursuing with ardour the honourable path which is marked by the footsteps of his ancestors.

* SINCE the date of this Memoir, Mr DUNDAS of Arncliffe has been appointed his Majesty's Advocate for Scotland, October 31. 1789. The late Lord President DUNDAS was succeeded in that office by Sir THOMAS MILLER of Glenlee, who, to the eminent loss of the public, and the sincere regret of all who knew him, died on the 27th day of September 1789. Upon that event, ILAY CAMPBELL, Esq; then Lord Advocate, was promoted to the Presidency of the Court of Session, and was succeeded in the office of Lord Advocate by Mr DUNDAS.

II. ACCOUNT of Sir ALEXANDER DICK, Bart. of Prestonfield,
late President of the Royal College of Physicians of Edinburgh,
and F. R. S. EDIN.

[Read by Dr DUNCAN, now Professor of the Theory of Medicine in
the University of Edinburgh, March 16. 1789.]

SIR ALEXANDER DICK of Prestonfield, was born on the 23d of October 1703. He was the third son of Sir WILLIAM CUNNINGHAM of Caprington, by Dame JANET DICK, the only child and heiress of Sir JAMES DICK of Prestonfield. While his two elder brothers succeeded to ample fortunes, the one as heir to his father, the other to his mother, the provision made for a younger son was not sufficient to enable him to live in a manner agreeable to his wishes, without the aid of his own exertions. His inclination led him to make choice of the profession of Medicine; and after being instructed in the preliminary branches of education at Edinburgh, he began his academical studies in the science of Physic, at the University of Leyden, under the celebrated BOERHAAVE, at that time the most eminent Medical Professor in Europe. After having completed the usual academical course under BOERHAAVE and his colleagues, he obtained the degree of Doctor of Medicine from the University of Leyden, on the 31st of August 1725; and, upon that occasion, he published an inaugural dissertation *De Epilepsia*, which did him much credit. Not long after this, he returned to his native country, and had the honour of receiving a second diploma for the degree of Doctor of Medicine, which was conferred upon him by the University of St Andrews, on the 23d of January 1727; and on the 7th of November

member of the same year, he was admitted a Fellow of the Royal College of Physicians of Edinburgh.

BUT after Dr CUNNINGHAM (for at that time he bore the name of his father) had received these distinguishing marks of attention at home, he was still anxious to obtain farther knowledge of his profession by the prosecution of his studies abroad. With this intention, he made the tour of Europe ; and although medicine was uniformly his first and principal object, yet other arts and sciences were not neglected. During this tour, he resided for a considerable time in Italy ; and there an elegant classical taste, and extensive knowledge of the history and antiquities of the country, could not fail to afford him a very high degree of gratification.

UPON his return to Britain, Mr HOOKE, a gentleman with whom he had formed an intimate friendship, and who possessed a large fortune in Pembrokeshire, persuaded him to settle as a Physician in that country. For several years he practised medicine there with great reputation and success, and was much respected and admired, both as a Physician and a Man. But his immediate elder brother Sir WILLIAM DICK, dying without issue, he succeeded to the family-estate and title, assuming, from that time, in terms of the patent and entail of that estate, the name and arms of DICK. Very soon after the death of his brother, he left Pembrokeshire, and fixed his residence at the family-seat of Prestonfield in Mid Lothian, little more than a mile from the city of Edinburgh.

ALTHOUGH he now resolved to relinquish medicine as a lucrative profession, yet, from inclination, he still continued to cultivate it as an useful science. With this view, he supported a friendly and intimate correspondence with the Physicians of Edinburgh ; and he soon distinguished himself, by paying particular attention to the business of the Royal College, among the list of whose members his name had been inrolled at a very early period of his life. In the year 1756, he was unani-

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Sir-Alex. Dick.

mously chosen President of the College; and as his fellow-members were fully convinced of his zeal, as well as of his abilities, they afterwards elected him to that office for seven years successively. It was their earnest wish that he should have continued still longer as their head; but this he positively declined, as he thought that he should thus deprive other gentlemen of a dignity, to which, from their merit, they were well entitled. But after his resignation of the office of President, his attachment to the College, and his earnest endeavours to promote its interest, continued unabated. He not only contributed liberally towards the building of a hall for their accommodation, but strenuously exerted himself in promoting every undertaking in which he thought that the honour or interest of the College was concerned. As a testimony of the sense which his fellow-members entertained of his services, a portrait of him was, by their unanimous suffrages, hung in their hall; a mark of distinction which has never been bestowed, either before or since that time, upon any other member.

BUT the College of Physicians were not the only set of men who were benefited by his exertions. He was long distinguished as a zealous and active member of the Philosophical Society of Edinburgh. And when they resolved to join their influence as a body, in seconding an application to the Crown from the University, for the establishment of a new Society under Royal patronage, and on a more extended plan, having for its object the cultivation of every branch of science, erudition and taste, he had an active hand in procuring the establishment of this institution. And accordingly, when his Majesty was graciously pleased to grant a charter for incorporating the Royal Society of Edinburgh, the name of Sir ALEXANDER DICK stands inrolled as one of the first in the list. For many years, he discharged the duties of a faithful and vigilant Manager of the Royal Infirmary of Edinburgh. It was his constant endeavour to render that establishment at once subservient to the relief

lief of the distressed, and to the advancement of medical education. And while he shewed himself a sincere friend to the poor, he was also remarkable for the countenance and encouragement which he gave to modest merit, particularly among the students of medicine. Indeed, possessing a high degree of public spirit, he took an active share in promoting every undertaking which he thought would be beneficial, either to his country in general, or to the city of Edinburgh in particular. To him, its inhabitants are much indebted for many excellent high roads in the neighbourhood; and hardly one internal improvement was suggested or executed, during his residence at Prestonfield, which he was not instrumental in promoting, with an activity which did him the highest honour.

WHEN the seeds of the true rhubarb were first introduced into Britain by the late Dr MOUNSEY of Petersburg, he not only bestowed great attention on the culture of the plant, but also on the drying of the root, and preparing it for the market. The success in these particulars was so great, that the Society in London for the encouragement of arts and commerce, presented him, in the year 1774, with a gold medal, which is inscribed to Sir ALEXANDER DICK, Bart. for the best specimen of British rhubarb.

Sir ALEXANDER was twice married, and has left children by both marriages. In April 1736, he married his cousin Miss JANET DICK, the daughter of ALEXANDER DICK, Esq; merchant in Edinburgh, and representative of the family of Sir WILLIAM DICK of Braid. By her he had five children, but of these two daughters only survived him. In March 1762, he married Miss MARY BUTLER, the daughter of DAVID BUTLER, Esq; of Pembrokeshire. By this lady, who survived him, he had seven children, of whom three sons and three daughters are still alive.

It would be a difficult matter to sum up his character in a few words. But it may with justice be said, that while he was
steady

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steady in the pursuit of every object which engaged his attention, his conduct in every transaction through life, was marked with the strictest honour and integrity. This disposition, and this conduct, not only led him to be constant and warm in his friendship to those with whom he lived in habits of intimacy, but also procured him the love and esteem of all who really knew him. Notwithstanding the keenness and activity of his temper, yet its striking features were mildness and sweetness. He was naturally disposed to put the most favourable construction on the conduct and actions of others. This was both productive of much happiness to himself, and of general benevolence to mankind. And that serenity and cheerfulness which accompanied his conduct through life, were the attendants even of his last moments; for, on the 10th of November 1785, he died with a smile upon his countenance. Although he had already passed the 82d year of his age, a period at which the faculties both of mind and body have in general so far failed, that death is rather to be wished for than otherwise, yet not only his judgment, but his spirit for exertion, still remained unimpaired. His death, therefore, even at that advanced age, was a great loss to society.

III. Ac-

III. ACCOUNT of the Right Honourable Sir THOMAS MILLER
of Glenlee, Bart. Lord President of the Court of Session, and
F. R. S. EDIN.

[Read by DAVID HUME, Esq; Advocate, F. R. S. EDIN. and Professor of Scots Law in the University of Edinburgh, Dec. 21. 1789.]

IT has often occurred to me, as a hard circumstance in the lot of those who follow the active employments of life, that however great their eminence, however useful their labours, nay, however rare and excellent their talents, the remembrance of them dies among their countrymen at large, almost as soon as they themselves are gone; and even with those of their own professions scarcely survives for more than a single generation. The records of the Royal Society are therefore in this respect valuable, that they afford the means of rescuing from oblivion, those of our Members who, by their professional eminence and services, have merited the gratitude and remembrance of their country, though their line of life did not permit them to attain distinction of another kind, by any literary work or discovery in science.

I THOUGHT it would be universally felt and allowed, that the late Sir THOMAS MILLER, (at one time a Vice-President of this Society), most justly fell under the above description of a singularly useful man, and fit to be commemorated. And in this persuasion, I have prepared a short account of him, now to be submitted to your consideration.

Sir

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Miller.

Sir THOMAS MILLER of Glenlee, late Lord President of the Court of Session, was the second son of WILLIAM MILLER, writer to the Signet, who was himself the second son of MATTHEW MILLER of Glenlee, and succeeded to that estate, along with the lands of Barskimming, on the death of his elder brother.

Sir THOMAS was born on the 3d of November 1717. He received the first rudiments of his education at Glasgow, and afterwards went through the usual course of academical studies in the University of that place; where he acquired a relish of the pursuits of literature and science, that never forsook him, and especially a fondness for the Greek and Roman classics, which, even in the busiest periods of his life, he occasionally found opportunities to indulge. HORACE was almost his constant companion; and even in his last years, after his promotion to the most laborious office in the law, HOMER, during a vacation, was often on his table.

ANOTHER branch of knowledge for which he there imbibed an early predilection, was that of Ethics, or Moral Philosophy. This he had the advantage of studying under the celebrated Dr HUTCHESON, of whom he was a favourite pupil. The warmth of eloquence with which this Philosopher poured forth his lectures, attached to him extremely all those of his hearers, who had any liking to the subject he treated, or were susceptible of being moved; and Mr MILLER, in particular, contracted not only a high admiration of his talents, but such love to him as a man, that long after his death, and when he himself had grown old, he could not mention his name but in terms of gratitude and veneration, equal to those in which the disciples of SOCRATES spoke of their master. Like SOCRATES too, Dr HUTCHESON taught his disciples to value Ethics beyond all other sciences; and with Mr MILLER this preference was so strong, that he used habitually in conversation, when distinguishing it from the rest, to give it the appellation of *Philosophy*.

HAVING

HAVING thus, by the improvement of his taste, and the acquisition of a philosophic spirit, made the best preparation for eminence in any liberal employment, he decided for the Bar, the profession to which those accomplishments lend the most distinguished lustre of any, and where they most materially contribute to the advancement of the person possessed of them. For some time he had hesitated between this profession and his father's; and it is said to have been in a great measure owing to the state of his health, that he gave up thoughts of the latter.

WHEN he had resolved on going to the Bar, he fixed his residence at Edinburgh, and devoted himself to the study of the law, with that zeal and earnestness with which, during his whole life, he was remarkable for following every object that had once determined his choice*. Yet with all his diligence in this necessary occupation, as the turn of his mind led him to no base or trifling pursuits, he was able to find time, and neglected not to employ it, for cultivating the humaner and more liberal studies. Even at this time, he continued to read the classics extensively, particularly the better *Greek* authors, having for his assistant the late Mr GEORGE MUIRHEAD, afterwards Professor of Humanity at Glasgow, whose reputation as a classical scholar is well known.

IN the month of July 1742, he was called to the Bar. Where he had not long continued, before the most favourable opinion came to be entertained, among the persons best entitled to judge, of the proficiency he had made in the knowledge of the law, and of his excellent qualifications, both for counsel and debate. His elocution was copious and easy; his selection of argument judicious, and his mode of presenting it, in the highest degree perspicuous and plain; and he accompanied it with a manner of delivery so weighty and fervent, as carried home to the

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hearer

* His usual hour of going to bed at this period was four of the morning.

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hearer the impression of his own belief in the doctrines he maintained. Men there might perhaps be in the profession, more eminent for invention of topics in a desperate cause, or who showed more versatility of genius in placing the same business in different lights, or turning it into all variety of shapes; but there was none who better understood the strength of a good or a tenable cause, or took his ground in one of that description with more judgment and discretion, or used its advantages to better purpose. Having found the soundest or most favourable part of his client's plea, *that* he attached himself to, and on *it* exerted all his strength; throwing aside, with just and proper confidence, all the more doubtful points and weaker considerations in the cause. Captious and quibbling argument indeed, and all perversion of an adversary's words or meaning, he held to be as foreign to the lawyer's duty, as they are derogatory to the honour of the Court where they are heard; nor could he, on any occasion, be prevailed on to attempt the aiding of his cause, in a manner so inconsistent with his own feelings of what was right and proper.

No wonder then, that thus qualified, and regulated by sentiments so respectable, he quickly rose to a high degree of employment in his profession, though he had among his contemporaries, for rivals in the public favour, men of the greatest acuteness and splendour of parts.

HENCE also he, at an early period of life, entered the career of public offices and honour in the department of the law.

IN the year 1748, on the new arrangement of the office of Sheriff, (which has been attended with so many salutary consequences) he was pitched upon as a fit person for one of those appointments. The county which Government had destined for him, was that of Inverness, in those times of recent disorder and rebellion, accounted the most important of any, and what required the steadiest and most able superintendence. But this appointment, though more advantageous, he declined; because
his

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his friend the Earl of SELKIRK had recommended him to Government for the stewardry of Kirkcudbright, and it had been understood between him and the Earl that he was to accept it.

THE duties of this office he performed with great punctuality, and to the entire satisfaction of the district entrusted to his charge; and he continued to hold it till the year 1755, when he resigned, and was named Solicitor of Excise—an office in those days generally held by a lawyer.

IN the year 1759, on the promotion of Mr PRINGLE (afterwards Lord ALEMORE) to the Bench, he reaped the fruit of the public favour, in being appointed his Majesty's Solicitor-General for Scotland.

IN the year 1760, he succeeded the late President DUNDAS as his Majesty's *Advocate* for Scotland; and in the following year, he was chosen to serve in Parliament for the burgh of Dumfries.

WHILE in these stations, Mr MILLER, whose modesty and discretion were equal to his ability, did not think it so much incumbent on him to take an active share in the debates of the Assembly, as to regulate his voice according to his opinion of the public good. The single occasion that called him up as a speaker, was indeed of a very interesting kind, and became a signal proof of the independence of his spirit, and sincere concern in the grandeur and prosperity of the British empire. This was the repeal of the American stamp act; a measure in which Mr MILLER's sagacity foresaw the miserable train of consequences that have since ensued from it, and which, though supported by all the influence of the then Ministry, he accordingly both voted against, and gave his reasons to the House for opposing:—A most respectable and truly patriotic piece of conduct, and of which he reaped a just, but unlooked for reward, in the friendship and esteem of the Marquis of ROCKINGHAM; who, however loath to have an opponent in the principal servant of the Crown for Scotland, yet, satisfied that he had taken

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this line from the purest and most disinterested motives, continued him in his public station, and ever after honoured him with his particular attention.

IN the year 1766, on the death of Lord MINTO, he was appointed Lord JUSTICE CLERK ; which office both bestows the Presidency of the highest Criminal Tribunal, and a seat as an ordinary Judge in the supreme Civil Court.

IN these high stations, he fully justified the choice that had been made of him, and soon, by his scrupulous attendance on the Court, and assiduous labour in the dispatch of business, gained a high place in the esteem and confidence of the public, as a man deeply impressed with the importance of his duties, and actuated by a warm and steady zeal conscientiously to discharge them. And this task he accomplished, in the civil department, in such a manner, as both added credit to the Court of which he was a member, and was of the most essential service to the interests of law and justice. For besides the learning and experience, acquired by long study and extensive practice, he was possessed of many other more material qualifications, which added much to the power of those attainments, and peculiarly fitted him for the important charge of deciding on the rights of his fellow-citizens.

HE was happy in a great natural temperance of disposition and soundness of judgment. Whence, though he was well able to pursue an intricate and subtle argument, and could, on proper occasions, successfully push an abstract principle into all its consequences, and was ever disposed to bestow the due share of praise on this sort of acuteness in others, yet few were so little apt to be dazzled by new or splendid notions, or less subject to the imposition of false refinement. His natural good understanding, joined to his knowledge of business, readily pointed out to him the real sources and objects of our customs and statutes, and the consequences to be dreaded, if these were at any time forgotten ; and thus, occupying on all occasions a
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strong and sure ground, he was not easily tempted to abandon it.

To the same constitution of mind, he was indebted for his particular eminence in *that* article, wherein perhaps lies the main difficulty of the Judge's task,—the discovering the precise application, or the inapplicability, of the general precepts of law to the particular case in hand. He was nowise apt to hasten to a sentence, but patiently suspended his opinion till the due investigations had fully ripened the case for judgment; which necessary preparation once made, he then earnestly applied himself to understand, and get possession of, the peculiar circumstances and proper complexion of *that* case. Whence it came, that in the course of the many years he sat upon the Bench, the number of his judgments as an Ordinary, that were altered on review of the whole Court, was almost incredibly small, and that, in a great proportion of the causes brought before him, the unsuccessful party acquiesced in his opinion, and carried the suit no farther.

HENCE also, in the deliberations of the whole Court, it often happened, (as many who now hear me remember), that, by detailing the cause to the Bench, (which he did with great force and perspicuity), and fixing upon special circumstances which others had overlooked, or less attentively considered, he was able to turn the tide of argument, and win his brethren over to his opinion.

YET, though this was perhaps his peculiar excellence, he was the very reverse of a minute or unsteady lawyer. He had, on the contrary, the firmest hold of the principles and spirit of the law in every department, and on all occasions that gave scope for general reasoning, ever drew his opinion, not from the authority of books and precedents, (which hardly any Judge ever dealt less in quoting), but from the source and fountain-head of the law,—the strain of our statutes, and the reason and substance of the thing.

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BUT in reciting his qualifications as a Judge, we must not forget *one*, which was in him amongst the most eminent of any, and on no occasion forsook or misled him,—the natural rectitude and pure honour of his own mind,—which, in the numerous class of causes that depend on the judgment to be formed of the character and conduct of men, directed him with certainty to whatever was faulty in either, and enabled him to show (which he did with much energy and feeling) what the conduct of a truly honest man would there have been. Indeed, upon such occasions, where the interest of morality, or the purity of judicial proceedings, was concerned, he was sometimes led to expatiate at a length which just taste might perhaps have been disposed to blame, had it been a less warm and pleasing proof of his native integrity and cordial attachment to the cause of virtue.

WITH all these powerful assistances, which so well qualified him to judge with firmness and decision for himself, he possessed the still more rare, and in a Judge inestimable endowment, of the most perfect candour, in listening to and weighing the sentiments of others; which virtue was in him so conspicuous, that it might with truth be said of him; that he had no predilection for any opinion, merely because it had once been his own: So ready was he to reconsider his judgment, the moment he saw any cause to doubt it, and with such perfect openness and indifference did he abandon it, however firm his former persuasion, upon being (from whatever quarter) convinced of an error.

THESE were his acknowledged merits as a Civil Judge. And his zeal for the public service as President of the Justiciary, was no less conspicuous and successful, as appears from more than one reformation, which the forms and practice of the Court underwent, during the period of his sitting at the head of it. Of these, the most remarkable was the fuller establishment of the distinction in our law between culpable homicide and murder;

a distinction which seems to rest upon the strongest grounds in reason and humanity, and even to be supported by the language of our books and statutes, but which, nevertheless, the older practice of the Court could scarcely be said to have thoroughly recognised, and which now, in a great measure, owed its reception into libels and verdicts to the weight of Mr MILLER's opinion, who lost no proper opportunity to countenance and inculcate so just a doctrine.

WE may also mention among the improvements by him suggested, the late statutory dispensation with the tedious, and often unnecessary process, of reducing the testimony of the witnesses into writing.

NOR must we pass over his attention to the exterior decorum of this tribunal, so important to the maintenance of its authority, and which he, in different ways, materially contributed to support; having abolished certain old, but unseemly practices, and introduced various becoming observances, not before his time required; and, above all, having personally added to the respect and gravity of the Bench, by his rare and happy talent of suitable, and earnest, and eloquent exhortation to the unfortunate convicts, which impressed upon the bystanders, and rendered salutary to them, the examples of justice which his duty constrained him to make.

Mr MILLER continued, thus honourably to himself, and profitably to the public, to discharge the duties of these stations, without interruption, till the year 1781; at which time, his health being somewhat impaired by so long a course of constant application to business, it was judged advisable for him to discontinue it, and make a short trial of a warmer climate. He accordingly spent some months in visiting different parts of France; and having thence passed into Italy, he had there the satisfaction of contemplating the magnificent remains of the grandeur of the people, for whose language and genius he entertained so high an admiration, and of surveying
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with his own eyes many of the picturesque scenes which had so often delighted him in the descriptions of their poets. He returned in perfect health, after being absent for about a year, and resumed his former occupations with his wonted vigour and activity.

IN the month of January 1788, on the death of President DUNDAS, he was, to the entire satisfaction of his country and the Bar, called to preside in the Civil Court. His Majesty, at the same time, thought proper to requite his long services, by bestowing on him the title of a Baronet of Great Britain.

It was a very difficult task for any man, the youngest and most vigorous, to enter on the extensive labours of this office, after the Lord President DUNDAS; whose singular powers for the rapid dispatch of business will always be remembered with regret, whoever the person be that fills his chair. Yet of his successor, during the short time he held it, we may with truth say, that he gained an accession of reputation, by his manner of conducting himself in this new station, though advanced to the age of *Seventy* before he attained it. And if he sometimes consulted with his brethren upon matters which he might have settled without such deliberation, this was almost unavoidable upon the first entry into office; at least in a person like Sir THOMAS MILLER, who, with the best pretensions to lead and direct, was free from all desire to exert his influence. This mildness of disposition secured to him, in an uncommon degree, the respect and affection of the Gentlemen at the Bar; whom he always heard with such patience, and treated with such attention and good breeding, as should, more effectually than the sharpest animadversion, repress all petulance and indecorum.

HAVING thus then gained the summit of his honest ambition, in rising successively, by his own talents and useful labours, to all the great offices of the law;—having obtained them all without blame or envy, and held them with credit and distinction;—happy in retaining, at an advanced age, the full possession

possession of health and of his faculties, and fortunate in his family and all his domestic concerns ;—he had little else to pray for, (since Heaven had ordered that he should now be called from the society of persons so dear to him) but an easy dissolution of his mortal state. And this Divine Providence thought fit to grant him.

HE died upon the 27th of September 1789, after an illness of two days, at his seat of Barskimming in Ayrshire, in the 72d year of his age,—leaving no good man his enemy, and attended with that sincere and extensive regret, which only those can hope for, who have occupied the like important stations, and acquitted themselves as well.

WE have spoken of him in his public capacity, and noticed his great temperance and solidity of judgment. Now, these qualities were in him the more to be praised, that they did not proceed from any coldness or tardiness of nature, but were, on the contrary, united to a very warm and feeling heart ; which was manifest in his whole life and manners.

No man was perhaps a better citizen, or more genuine patriot, than the late President ; if we are to esteem *him* such, who not only takes an interest in the internal welfare and prosperity of his country, but feels an honest pride and warm concern in its glory and consequence as a state, and in the splendour of the peoples fame. Of all these, the President had, and continued to have, even in his latest years, a most lively sense ; which was, at one period of his life, the source of much joy and satisfaction, and at a later period, of sincere mortification and regret, and caused him often to lament to the rising generation, during the misfortunes of the late war, that they had only seen a glimpse of the glory of their country. That part too of the British dominions which gave him birth, he was attached to with all the partiality which a good man naturally feels ; nor was there any subject on which he dwelt more frequently,

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Miller.

quently, or with more pleasure, than its growing state of improvement in his own time.

HE was, in like manner, a very social and hospitable man; to his family, and connections, and indeed to all about him, full of gentleness, and kindness, and cordiality: and this uniformly and without exertion; insomuch that no person whom he had reason to esteem or think well of, could ever say of him, that he received him coldly, or treated him with reserve*. Good breeding indeed, (meaning by the term that kind and open manner which sets a stranger or inferior at ease) was in a manner natural to him; and he had it to all ranks and conditions of men; so that in a humane visit to the house of a servant or dependant, he equally pleased, and was as surely directed to the very things that were fit and acceptable to be said, as in his intercourse with those of his own rank. Among whom too, and indeed in all situations, he was distinguished for a rare simplicity of manners and openness of speech; which flowed from a purity of thought and intentions, so perfect that it was not to be surpassed.

HE retained through life the highest relish of the beauties of nature, and every year spent a considerable part of the recess of business, in the enjoyment and improvement of the romantic

* HERE we must observe, that however remarkable this gentleness and disposition to oblige, they were yet always confined to their proper sphere, and in no instance suffered to interfere with what he esteemed his duty. This appeared, among other examples that might be given, in his spirited behaviour as Lord Advocate, on occasion of a question that arose touching the pre-eminence of his office. The late Mr CHARLES YORKE had been honoured with a patent of precedence over his brethren at the Bar, with exception only of the Attorney-General; and happening to be engaged as Counsel in the House of Lords, on the same side with Mr MILLER, he, under this privilege, claimed right to be heard before him. Mr MILLER, though in habits of intimacy with Mr YORKE, and personally very indifferent about any such distinction, felt himself here in duty called upon to resist his friend's pretensions; and accordingly maintained (nor could be prevailed on to recede from it) that he, as his Majesty's Advocate, was Attorney-General for Scotland, and within the exception of the patent. The point was in the end referred to the opinion of Lord MANSFIELD, which was given in favour of Mr MILLER.

tic scenes at his place of Barskimming. It was not, however, to the object of beauty alone, that his attention at those seasons was directed, but also to the better management and substantial melioration of his estate. And this pursuit engaged him in very numerous and extensive operations, all of which he himself both planned, and superintended the execution of, and successfully conducted ; though in the hands of most other men, having the same avocations of business, without the same activity, constancy and love of order, they were more likely to have proved abortive, or even ruinous.

Sir THOMAS MILLER was twice married. By his first wife, MARGARET MURDOCH, daughter of JOHN MURDOCH, merchant in Glasgow, he left issue ; one daughter, and one son, now Sir WILLIAM MILLER, who follows the same profession in which his father rose to such distinguished honours. His second marriage (of which there is no issue) was to ANNE LOCKHART, daughter of Mr LOCKHART of Castlehill, who has the misfortune to survive him. His eldest brother JOHN had deceased some years before him, and he succeeded, on that event, to the family estate of Glenlee, which, along with the estate of Barskimming, has now devolved to his son.

END OF THE HISTORY.

*DONATIONS presented to the ROYAL SOCIETY of Edinburgh,
continued from the preceding Volume.*

By *John Macgowan*, Esq; Edinburgh,

Anacardium Occidentale. LIN. The Fruit of the Cashen Tree,
preserved in spirits. No. 722.

Castor Fiber. LIN. The Beaver, from Hudson's Bay. No. 723.

Felis Lynx. LIN. The Hudson's Bay Lynx. No. 724.

Canis Lagopus. LIN. The Arctic Fox, from Hudson's Bay.
No. 725.

Crotalus Miliarius. LIN. The small Rattlesnake. No. 726.

Coluber Alternus. No. 727.

By the Right Honourable Lord *Daer*.

A number of articles, collected in the South Seas by Captain
BLIGH.

Two parcels of fine New Zealand Hemp. No. 728.

A Musical Instrument made of Reeds. No. 729.

An Arrow-head, formed of a hard black Schistus. No. 730.

Fish-hooks of Mother of Pearl, and Lines, from the Friendly
Islands. No. 731.—733.

Fish-hooks, and Lines, formed of the Sinews of an Animal
from the coast of America, in Lat. 49° N. No. 734.—736.

Capnias Australis,
Smectis Australis, } from the South Sea Islands. No. 737.—739.
Catochites Australis,

By *John Davidson*, Esq; of Ravelrig.

A Lion's Skin, with the Head, Teeth and Claws, from the Cape
of Good Hope. No. 740.

List of Donations.

Two Sea-weeds, taken out of the Atlantic, at a great distance from any land. No. 741. 742.

Six Arrows from Bengal. No. 743.

A Malay Poinard. No. 744.

Lapis Judaicus, from the East Indies. No. 745.

By *John Learmonth*, Esq; Merchant in Edinburgh.

Scolopendra Gigantea, LIN. above fourteen inches long, from the West Indies, preserved in spirits. No. 746.

By Professor *Dalzel*.

A Sceptre of Ivory, mounted with silver, given by the King of Dachomy, in Africa, to *Archibald Dalzel*, Esq; formerly Governor of Whydah, as a testimony of friendship. No. 747.

The Horn of an Antelope, from Africa. No. 748.

By *James Boswell*, Esq; of Auchinleck.

Some large Nodules of Flint, from Italy; each having crystallisations in a large central cavity, sent from Leghorn by Sir *John Dick*. No. 749.

By Captain *Liddel*.

A white Greenland Bear. No. 750.

By *Francis Kinloch*, Esq; of Gilmerton.

Colymbus Arcticus, LIN. shot on the shore of East Lothian. No. 751.

By the Honourable Lord *Hailes*.

Trichechus Rosmarus. LIN. The Morse or Sea Horse; the Skeleton of the Head entire, with the Tusks. No. 752.

By

By Mr *John Macaulay*, Town-clerk of Dumbarton.

The Horn of a Stag, of a singular form, dug out of a stratum of Clay in Dumbartonshire. No. 753.

By the Right Hon. the Lord Chief Baron *Montgomery*.

An Indian Canoe, of fine workmanship, from the Island of St John. No. 754.

By Dr *Gregory*.

A large Lizard, from the West Indies, preserved in spirits. No. 755.

By *William Henry Charters*, Esq; of Burntisland.

Lava Garnets, found in the Lava, which overwhelmed Pompeii. No. 756.

Two Copper Coins. No. 757. 758.

A Silver Coin of *Henry VI.* struck at Calais, and found in the river Jed. No. 759.

By Dr *Roxburgh* at Madras.

A Chest of Plants from Bengal and the Peninsula of India, containing several hundred Plants, in fine condition, and arranged according to the Linnean system.

By *The American Academy of Arts and Sciences*.

Memoirs of the American Academy of Arts and Sciences, to the end of the year 1783, Vol. I. 4to. Boston, 1785.

By *The Royal Irish Academy*.

The Transactions of the Royal Irish Academy. 4to. Dublin, 1787.

By

List of Donations.

By *Adair Crawford*, M. D.

Experiments and Observations on Animal Heat, and the Inflammation of Combustible Bodies, &c. The second edition. 8vo. London, 1788.

By *Dr Carlyle*.

The Husbandry of the Ancients, by *Adam Dickson*, A. M. late Minister of Whittingham. 2 Vols. 8vo. Edinburgh, 1788.

By *E. Peart*, M. D.

The Generation of Animal Heat investigated, &c. 8vo. Gainfborough, 1788.

By *M. Lavoisier*.

Traité Élémentaire de Chimie. 2 Vol. 8vo. à Paris, 1789.

By *Thomas Percival*, M. D.

Essays Medical, Philosophical and Experimental, Vol. II. 8vo. 4th edition, revised and enlarged. Warrington, 1789.

By the Reverend *Archibald Alison*, A. B.

Essays on the Nature and Principles of Taste. 4to. Edinburgh, 1790.

T R A N S-

I.

PAPERS OF THE PHYSICAL CLASS.

I. *Of certain NATURAL APPEARANCES of the Ground on the Hill of Arthur's Seat. By JAMES HUTTON, M. D. F. R. S. EDIN. and Member of the Royal Academy of Agriculture at PARIS*.*

IN summer 1776, Professor FERGUSON observed a particular appearance on the hill of Arthur's Seat, near the summit, which drew his attention, and which he could not understand. He then carried Dr BLACK and me to the place, where we found something which, at a distance, resembled the withered grass of a foot-path, but which traversed a shoulder of the hill, in such a direction as corresponded to neither sheep-track nor foot-path. Upon a near inspection, it appeared to be a narrow stripe of the grass quite dead and withered. The breadth of this stripe was about nine, or, in some places, twelve inches; the sides of this track were perfectly defined, without any gradation from green to withered grass, all the plants in the track being killed, without the contiguous part having suffered in the least. The length of this track was considerable, a hundred yards or two, extending from the south-east side of

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the

* This Paper was read before the Philosophical Society of Edinburgh in June 1778. It is now printed by order of the Committee for publication of the Transactions of the Royal Society of Edinburgh.

the southmost hill through a hollow, and ascending obliquely the shoulder of the summit of Arthur's Seat on the south-east side.

At first thunder suggested itself as having been the cause of this remarkable appearance; but the more we enquired into the particulars of this phenomenon, the greater difficulties occurred with regard to the proper correspondence of that conjectured cause, as well as for assigning any other with the least degree of probability. It is with a view to make this appear, that the following history is made of the particulars which were at that time, and have been since observed.

OBSERVATION 1. THE appearance now described was not the only one of the kind; for, upon examination, I found similar tracks, though of various extent, in all the different aspects and situations, from the south side of the summit to the north side of the hill half way down to the plain; but none at the bottom.

OBS. 2. THESE appearances, though recent, or of that year's production, had not been the first thing of that kind which had appeared on the hill; for, parallel to each of those tracks of withered grass, there was another perfectly similar, which then appeared to us as if it had been made the year before, and was then black, the grass having rotted. The distance of this old track from the new, was, in general, only a few inches, sometimes exceeding near, but rarely or never contiguous.

OBS. 3. THE tracks, now under consideration, have been considered as a thing continuous in its length; but this it is only in general, or in certain portions where it is so sometimes for a considerable extent. In other places, again, it is composed of several portions of various lengths, the grass being unaffected betwixt those portions which make up the track; so that, in some places, the track is made as it were by spots; and these spots, although in general longer in the direction of the track, are not always so, there being in some places, generally at the
extremity

extremity of the track, spots whose length do not exceed their breadth.

OBS. 4. THE regularity with which those two tracks run parallel and near to each other, is not more wonderful than is the correspondency that is in general to be observed with regard to the construction of these, as consisting either of a continuous track or of separate pieces; and to so great a degree is carried this resemblance of the two tracks, that, where it is by spots the tracks are made, there the similarity, even of the spots, were sometimes remarked, so that it seemed as if the one had been a copy of the other.

OBS. 5. BESIDES the brown colour of those new made tracks, which might be seen at a considerable distance, (two or three hundred feet), there was another stripe of a dark green, which might be seen at a still greater distance. Upon more close examination, this last appearance was found to take its origin in some grass of a very dark green, which, in some places here and there of the last year's track, began to grow in the black ground and among the rotten grass; but the greatest part of this deep green was behind the last year's track, and was evidently owing to a similar growth of grasses in places which had been formerly killed or withered, and were now almost covered with new plants, which gave a deeper shade of green than the rest of the hill.

THIS last observation led to another; for here a question naturally occurred, That, since this succession of things had certainly taken place at least three years, how many successive tracks might be detected from the examination of those appearances? With this view I considered attentively some places where the marks were most distinct, and could plainly count five or six successions; the number cannot be accurately ascertained, because those which have been made above three or four years are much effaced, although the colour, and some other marks, evidently prove, that there had been several more.

OBS.

Obs. 6. THE tracks which have been now described, are not straight lines, but have all more or less of a regular circular nature in them; that is to say, they are segments of circular figures, and only approach to the appearance of right lines, in proportion as the figure of which they are the segments is large, or the segment small; and in those respects there appears to be great variety. There is, however, one appearance which, at first sight, might impose upon an observer, and destroy the generality of this observation. It is an instance or two that occur of a continued line in those tracks; but, in this case, the line appears to be made up of several segments, each of which ought to be considered by itself; consequently, here will be acknowledged the operation of the same general principle by which, in those appearances, a regular figure is produced, and that this figure is in its nature circular.

Obs. 7. THE production of those tracks being successive in its nature, or operating in different places at different periods of time, suggests another subject of enquiry, *viz.* How far any regularity, or a certain order, may be observed also with regard to this operation, as well as with regard to that by which the figure is produced? And this, from observation, I think, is determined in the affirmative, so far as, from all the observations I have made, this progress seems always to have proceeded in the direction of a line, drawn from the centre, bisecting the segment; that is to say, those portions of concentric circles are never inscribed, but always circumscribed; and, for this reason, it will appear, that those circles, of which segments are exhibited to our observation, must be increasing, and not diminishing, in their diameter.

HAVING thus given an account of what was concluded from the first season of those observations, before proceeding to give the continuation of their history, it may be proper to observe, that an unsuccessful attempt was once made to investigate the
cause,

cause, by the inspection of the turf cut up, and compared with that immediately contiguous to the track ; for, on that occasion, nothing was found that could give any light into the nature of the operation.

FROM the narration of appearances already made, the history of what has happened since that summer, 1776, will be extremely short, and may be comprehended in two or three words.

IN the summer 1776, there was prognosticated a succession of appearances similar to those which, from the observations then made, had been concluded as having already come to pass, and been transacted with a certain regularity in a former period of time. The event has fully justified the judgment which was formed at that time, respecting the order and regularity of the appearances, and has also left us in the same state of uncertainty, or rather ignorance, with regard to the cause.

IN the spring, about the month of April, the grass begins gradually to wither and decay. It is perfectly dead in a little time, that is, in a week or two, and then appears white or withered. Thus, every plant being killed in the new track, those vegetable bodies, exposed to heat and moisture, gradually decay, so as next year to exhibit a dark or black, instead of a light or white track, which it had been the year before ; but during the second year, the dead plants are still observed in the turf, which, as it begins to get new plants, loses gradually the appearance of the old ones, until at last little more can be observed, than a broad shade of a much deeper green, which, on the one side, is compared with the natural verdure into which it sometimes seems gradually to terminate ; whereas, on the other side, the deep green colour of the ground formerly tracked, is contrasted with the yellow or light colour of the withered grass.

FROM the inspection of the ground, and the history of what has been observed to happen, nothing is more evident than that this regular successive operation has been now repeated, at least
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in some parts of the hill, for eight or nine years. Here, therefore, is a piece of natural history worth recording, and for which a theory is wanted.

THE appearances which have been here described are, so far as I know, singular and unconnected with all others resulting from known causes. I know that similar circles have been observed by naturalists, and by them ascribed to thunder; as we should certainly have done in this case, were it not for the regular annual progression, which, if the effect of thunder, must follow rules not yet investigated, either in electricity, vegetation or the mineral system; for,

How comes it, that the electrical operation takes place regularly in the spring only, and that without any appearance of thunder?

2dly, How comes it, that the stripe of grass destroyed by one operation, is always regularly progressive in one particular direction, in relation to the first electrical operation?

3dly, If this progressive appearance shall be considered as an electrical operation, and every successive repetition as directed by the one immediately preceding it; then, how was the first produced; when was it; and when will be the last?

THE next conjectural cause that suggests itself as an explanation of those appearances, is the operation of insects. But there seems to be no less difficulty in reconciling any known animal-economy with the appearances under consideration, as the only cause of those appearances; for,

How should those animals have been distributed in those separated tribes upon the hill, and disposed in the continuous tracks, so as to exhibit lines of long extent, traversing ground and soil of various quality, as well as in tracks of very little extent; but, whether great or small, formed upon the same principle, every part having a similar relation to a whole?

ARE these large tracks to be considered as the extension of colonies which once had been small? or, Are these colonies dropped

dropped from the atmosphere upon the different parts of the hill, in the shape and extent in which we find those stripes of withered grass? This last hypothesis is not supported by any appearance that I know of in this country; and the other is not consistent with the natural appearances to which it must belong; for the solitary or insulated spots, which often form part of a stripe, seem to be reproduced, in nearly equal quantity, each succeeding year, without any gradual extension in the stripe, which also seems to preserve its former extent, as well as breadth and form.

THEREFORE, when we consider the various situations and extent of those narrow stripes of withered grass, the regularity to be observed in their shape and progression, and the constancy which seems to take place with regard to their succession, we must, at the same time, be persuaded, that there is a natural cause which may be investigated for the explanation of those appearances, and reject the mere supposition of causes which do not seem, of themselves, adequate to the effect perceived.

GREAT attention would be required in making observations with a view to discover the cause of those appearances; and the difficulty of this task is much increased by an ambiguity which occurs on certain occasions, where the breeding of insects in consequence of the death of plants, may be mistaken for the death of plants in consequence of insects; but, on the other hand, in the present case, great advantage, for an enquiry of this sort, may be derived from the opportunity that there is of examining, not only what had been killed the preceding, but also that part which is, perhaps, to be killed the ensuing season; and where experiment may be made by cutting off the communication betwixt those two parts as deep as the soil may admit.

THE apparent production, or rather the multiplication of some species of animals, in consequence of a certain destruction

of the vegetable turf, is a thing easily to be conceived, like what happens in those stripes the second year, when I have seen an abundant crop of a certain species of mushrooms in the track. Had animals of a particular species been found there, in the examination of the soil in those withered tracks, a rash conclusion might have been formed, in erroneously attributing as a cause for the appearance, what was truly an effect or consequence of the thing in question.

It is always making a step towards the discovering the cause of a phenomenon, when causes which, with some degree of probability, have been ascribed to an event, are found to be unconnected with, or to have no affinity to it; for this is the natural method of investigation, by examining the affinities or relations of things, and rejecting those as properly related, where there is found a discrepancy. Thus, as there is no effect without its proper cause; so, in proportion as a greater number of events are found to be unconnected with an appearance, some kind of approach is made towards that by which the natural appearance is to be explained; but in cases where events are multiplied or numberless, every approach of this kind is only negative; and such a method of investigation, while it may be the means of discovering the thing in question, only shows that what we want is not attained. This, however, if made with full conviction, is no contemptible step in natural philosophy, where, next to the investigation of the proper order in events, it is of the highest importance to avoid, or to correct, the improper connection of them.

THE explanation of the phenomena, in the present piece of natural history, either by thunder or the operation of insects, without having observed the actual connection of those different events, is merely conjectural, as would be equally the refusing to admit for explanation a known cause, which, though not actually observed as connected with the event in question,
had,

had, in other respects, the requisites for producing a similar effect.

BUT all that is known at present of electricity, or the operation of insects, is far from being sufficient to be considered as the explanation of the appearances in question ; for,

THOUGH the growing plants, or the vegetation of a portion of the living turf, may be killed either by means of electricity or insects, these are not the only means by which that effect may be brought about ; at the same time that this is the only circumstance, in the natural appearance, explainable by the supposed cause : Therefore, as every circumstance in an appearance must be properly related to a cause, by which it is to be explained, so the many circumstances here found, without any affinity to, if not inconsistent with the conjectured cause, will leave no room for admitting such an explanation, according to the present view which has been given of the subject.

II. *An Account of the Method of making the OTTER of ROSES, as it is prepared in the East Indies. Communicated in a Letter from DONALD MONRO, M. D. of London, to Mr JOHN ROBISON, Professor of Natural Philosophy in the University of EDINBURGH*.*

S I R, *London, F ermyn Street, July 10. 1783.*

I HAD the following receipt for making the *Otter of Roses*, as it is prepared in the East Indies, from Major MACKENZIE of Coull, in the county of Ross, who told me he got the account from an officer of his corps, who was up in the country where it is prepared, and assisted in making it himself.

TAKE a very large glazed earthen or stone jar, or a large clean wooden cask ; fill it with the leaves of the flowers of roses, very well picked, and freed from all seeds and stalks ; pour on them as much pure spring water as will cover them, and set the vessel in the sun in the morning at sunrise, and let it stand till the evening, when take it into the house for the night ; expose it in this manner for six or seven successive days, and, at the end of the third or fourth day, a number of particles, of a fine yellow oily matter, will float on the surface, which, in two or three days more, will gather into a scum, which is the *Otter of Roses*. This is taken up by some cotton, tied to the end of a piece of stick, and squeezed with the finger and thumb into a small phial, which is immediately well stopped ; and this is repeated

* Read in the Philosophical Society of Edinburgh in 1783 ; and published by order of the Committee for publication of the Transactions of the Royal Society of Edinburgh.

repeated for some successive evenings, or while any of this fine essential oil rises to the surface of the water.

N. B. I HAVE been informed that some few drops of this essential oil have been more than once collected by distillation, in the same manner as the essential oils of other plants here in London. I am,

S I R,

Your most obedient humble servant,

D. MONRO.

III.

III. DESCRIPTION of a MERCURIAL LEVEL, *invented by*
ALEXANDER KEITH, Esq; F.R.S. & A.S. EDIN..*

FIGURE 1. is a section of the instrument formed of mahogany or boxwood. AA are two oblong square cavities connected together by a narrow close channel, running from the bottom of the one to the other. BB are two grooves hollowed out of the wood, in order to contain the sights, &c. They are shut up by a lid, which turns upon a screw-nail at the centre C, as may be seen more distinctly from fig. 4.

FIG. 2. DD are the two sights, the one with a small hole, the other with a cross-hair. These sights are erected upon two pieces of ivory or hard wood, which are shaped nearly of the dimensions of the cavities AA, but so much smaller as to enter without touching or rubbing on the sides. Mercury is poured into the two holes AA till they are about half full; the two pieces of ivory which support the sights, are put into the cavities, and float on the surface of the mercury.

FIG. 3. is a perspective view of the instrument when the sights are floating upon the mercury; and fig. 4. is another view of it, when the sights are taken out and the lid is open.

As the two cavities communicate with each other, the surface of mercury in both are always upon the same line of level; and consequently, if the two sights are once accurately adjusted, they will ever after point out the true level, without requiring any after adjustment.

WHEN this instrument is to be used, it may be laid on any horizontal surface, and the sights will immediately become an exact

* This Paper was read before the Philosophical Society of Edinburgh in December 1778; and is now printed by order of the Committee for publication of the Transactions of the Royal Society of Edinburgh.

exact level. It may also be fixed on a tripod as the spirit-level; or it will answer equally well, if it is affixed to the top of a single stake, which is sharpened at the point so as to be pushed into the ground. If it is to be used as a pocket-instrument, it may be made of seven inches length, being about double the dimensions of the annexed draught. A common walking cane forms a very convenient support. It is affixed to the cane by means of a brass pin E, which passes through the hole G, and through the eye or hole of the walking stick; and a brass nut F, screwing to the male-screw of the brass pin, keeps them firm together. The two grooves BB, contain the two sights and brass pin, when not in use. Two corks, covered with thin leather, fitted into the holes AA, confine the mercury, when the instrument is to be transported; or, in case the mercury is found to escape, it may be poured into a small case, made of lignum vitæ, like a tooth-pick case; and this may be stopped with a cork, and made to fit into one of the grooves.

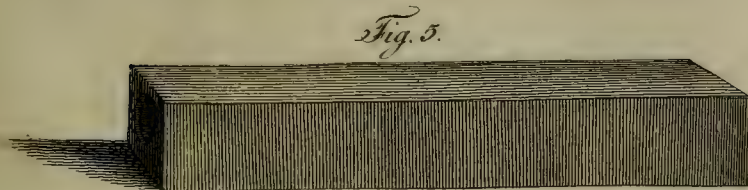
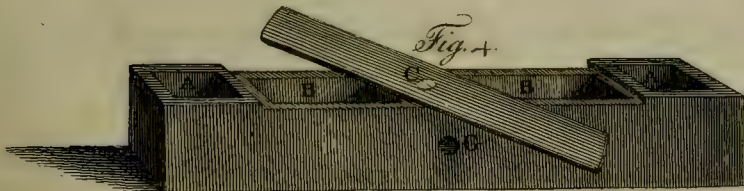
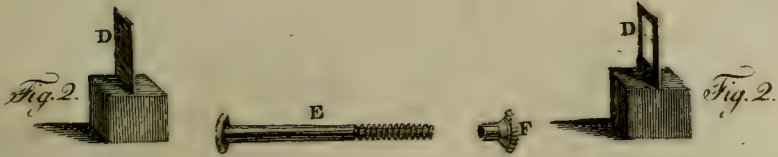
THE advantages of this instrument over the spirit-level are: 1st, It requires no adjustment, consequently two observers, though otherwise not equally accurate, must make the same observation. 2^{dly}, With this, the level of twenty different places may be taken during the time required to adjust the spirit-level for one observation. 3^{dly}, The nicety of the spirit-level depends upon the small curve of the glass-tube, in the choice of which no rule can be laid down; neither is any thing gained, in point of exactness, by lengthening the spirit-tube above three or four inches. But every instrument of this kind is of one standard; and the further the two sights are removed from one another, the more any error is diminished. 4^{thly}, This instrument can be made perfectly just, without taking any observation, or comparing it with another level. In order to do this, let the floats on which the sights rest, be of the same dimension and weight, and let the cross-hair and eye-hole be of one height, and, without farther adjustment, they will point out the true level.

THE

THE following is a proof of the exactness of this method. JOHN MILLER, the mathematical instrument-maker, has a line drawn upon the opposite side of the Parliament-square, fronting his shop, by which he has been in use to adjust his spirit-levels. We placed the mercurial level upon the spot known to be upon an exact level with the line. Both he and I looked through the sights; but could not perceive the line. We suspected there was some fault in the sights; but, on making them vibrate, we found that the hair had covered the line; so soon as they settled, the line was again covered by the hair.

WHEN there is a strong wind, the sights vibrate too much. In order to remedy this, there is a case of tin'd plate or paste-board made to inclose the instrument when not in use. *Vid.* fig. 5. When used, the case covers only about one half of it, leaving room for the sights to float within the case. There are two oval holes at each end of the case through which the observations are made.

[To fold out, facing page 16. Phys. Cl.]



I. Beugo Sculp.



IV. PATHOLOGICAL OBSERVATIONS *on the* BRAIN.

*By Mr THOMAS ANDERSON, F.R.S. EDIN. Surgeon at
Leith, and Fellow of the Royal College of Surgeons *.*

THE following observations may serve to illustrate and confirm the opinion now very generally adopted by Anatomists and Physicians, That an affection of one hemisphere of the brain, whether from internal disease or external accident, produces its morbid symptoms on the opposite side of the body.

CASE I. A LADY about forty, whom I attended along with Dr MONRO, was for many years affected with violent headachs; she complained of the pain being most violent in the crown of her head, which at last brought on convulsive tremors of the left arm and leg; these often continued half an hour, and would return three or four times a-day; the fits grew more severe and frequent, and the right side became affected, and frequently she was comatose for twenty-four hours, till, quite worn out, she died in November 1770.

ON opening her head, when the dura mater was taken off, on the right hemisphere of the brain, there was a loss of substance, for about two inches and a half in length, one and a half in breadth, and about the middle near an inch deep, the length of which was in the direction of the falx: In the middle of this, immediately under the coronal suture, and on the side nearest to the falx, within an inch of it, there was some soft

VOL. II. c brownish

* Read, before the Philosophical Society of Edinburgh in 1781; and now printed by order of the Committee for publication of the Transactions of the Royal Society of Edinburgh.

brownish matter in the bottom, on touching of which with the knife, I discovered stony concretions, which were taken out and washed. Several of them broke into sand on the slightest touch; but four or five of them, each about the sixth of an inch in length and breadth, and a little thicker than the shell of an egg, I saved, and afterwards gave to Dr MONRO, who was not then present.

CASE 2. WILLIAM C. about forty-five, of a corpulent habit, was, for several years, subject to epileptic fits, which commonly returned every three or four weeks, and any irregularity in eating or drinking would immediately bring them on; but when cautious, living sparingly, and taking some laxative, he was often free from them for four or five months.

THE fits always came on with convulsive motions in the right arm and leg, which, in a few minutes, were succeeded by stupor, in which he continued above half an hour. In November 1775, he received a stroke on his head, which brought him to the ground; was instantly seized with one of the fits; and, in twenty-four hours, had ten or twelve of them, in all of which the only parts convulsed were the right arm and leg; the fits became more frequent, a total stupor came on, and he died fourteen days after.

ON opening his head, on the left hemisphere, immediately under the coronal suture, and an inch from the falx, the dura mater adhered to the brain, for about the size of a shilling, and was so much thickened and hardened as to be in a cartilaginous state; the brain, for the size of a large walnut, was much hardened, and the under part of it adhered slightly to the falx; on the outer side of this hardness, on that side furthest from the falx, and in the middle of the substance of the cerebrum, there was about an ounce and a half of extravasated blood, which was soft, and of a black colour.

CASE

CASE 3. ROBERT H. a sailor, about forty, when on board of ship, stooping down, received a violent stroke on the back part of the parietal bones by the falling of a boom ; there was no wound, but the parts were much bruised. Some months after, he complained of a pain immediately under the part on which he received the stroke, which gradually grew worse, and in a year and half the pain was most excruciating, and brought on violent convulsions in both upper and lower extremities of both sides, the violence of which, in some months, put an end to his life.

ON opening the head, the posterior part of both hemispheres of the brain was found greatly inflamed and much hardened ; and adhered firmly to the dura mater and the falx ; the left side was more diseased than the right, and the dura mater, in some places where it adhered firmly, was much thickened, and almost cartilaginous.

CASE 4. Mr L. by a fall down a stair, fractured the left parietal bone. I saw him in half an hour, when he was in a stupor. He was immediately bled very plentifully, and then carried home. The fracture extended from the middle of the bone downwards and backwards, and was traced near to the mastoid process ; but I could not carry the incision any further. A piece of the bone was taken out by the trepan ; a considerable quantity of extravasated serum and blood was found pressing on the dura mater, which was got out ; the wound was dressed, and he was bled very plentifully a second time ; after which he became sensible, and answered distinctly when spoken to, and, after sleeping some hours, was greatly relieved, but at times the right leg and arm were attacked with convulsive tremors, which continued for three days, and, on the fourth day, every symptom appeared very favourable, and he had the appearance of doing well ; but he frequently complained of a pain in his head. On the twentieth day, he was seized

with rigor, which was succeeded by a feverish paroxysm, that frequently returned for three days; his pulse became constantly quick, and he died the twenty-eighth day. His friends would not consent to his head being opened.

CASE 5. ALEXANDER H. a lad of eighteen, fell into the hold of a ship about fifteen feet down, and was carried home in a stupor. A tumefaction was observed on the top of the right parietal bone. After a plentiful bleeding, he recovered of the stupor; a laxative was given, and he was bled again in the evening. On the third day, the stupor returned; and, on the evening of that day, I was called in, when there was every symptom of compression of the brain, and next morning Dr MONRO and Dr AUSTIN were sent for. It was then judged proper to examine the state of the right parietal bone, where the tumefaction was at first observed. No fracture could be found; but a piece of the bone was taken out by the trepan. Nothing was seen that could occasion any pressure. The stupor, &c. continued, and he died the thirteenth day. Eighteen hours after his death, I went to open his head; but such a degree of putrefaction was come on, that a great part of the brain had come out of the hole in the bone, quite dissolved and putrid. The teguments were taken off, but no fracture was found in any part of the head.

CASE 6. A sailor boy of fourteen fell into the hold of a ship. He was carried ashore in a stupor. There was a swelling on the middle of the right parietal bone, without any wound. He was bled, and put to bed; and, in half an hour, was so much recovered, that it was thought unnecessary to inspect the state of the bone. He was ordered a laxative to take in the night; but next morning it had not operated. It was then repeated; and in the evening he appeared very well; but there seemed to be a degree of torpor in the intestinal canal, from the
laxatives

laxatives not operating. A clyster was given, and the laxative again repeated. Next morning, his left arm and leg were quite paralytic, the pupil of the left eye was dilated, and did not contract when a lighted candle was brought near it, nor was he sensible of its being there; but he could read distinctly with the other eye, and the right leg and arm were very well. In the afternoon, just forty-eight hours from the time that he met with the accident, the bone was laid bare, and in the middle of the right parietal bone, a piece was found to be broken off more than an inch square. The upper side had pierced the dura mater, and gone into the substance of the cerebrum. The broken piece was easily taken out, and the wound dressed. Immediately after, the pupil of the left eye contracted, and he could distinguish large objects with that eye, and the leg and arm were less affected. He had a good night, and next morning could read when the right eye was shut. On the third day after the operation, when the wound in the dura mater inflamed, and a considerable tumefaction came on, his left eye, leg and arm became again paralytic, with frequent convulsions in the left leg and arm, but without the smallest complaint in the other side. In this state, he continued for several days; a suppuration came on; the swelling went off; after which he continued well, and the wound healed up in eight weeks.

FROM these cases, I should infer:

1. THAT when one hemisphere of the brain is affected, it generally produces its morbid symptoms on the opposite side of the body.

2. THAT when both hemispheres are affected, the whole body suffers.

3. THAT though one hemisphere only is affected, when the injury is great, the whole body will suffer.

4. THAT

4. THAT though the cerebrum alone is hurt, it produces morbid symptoms in all muscles of voluntary motion, whether their nerves take their rise immediately from the cerebrum, from the cerebellum, or from the medulla oblongata.

5. THAT, in cases of external accident, where one side is affected, it is more favourable than when both sides suffer.

V. EXPERIMENTS *on the* EXPANSIVE FORCE of FREEZ-
ING WATER, *made by* Major EDWARD WILLIAMS *of*
the Royal Artillery, at Quebec in Canada, in the years 1784
and 1785. Communicated in a Letter from CHARLES
HUTTON, LL. D. F. R. SS. LOND. & EDIN. *and Professor*
of Mathematics in the Royal Military Academy of Woolwich,
to Professor JOHN ROBISON, *General Secretary of the Royal*
Society of Edinburgh.

[*Read by Mr ROBISON, Nov. 6. 1786.*]

S I R,

THE following is an extract of a letter to me from Major
EDWARD WILLIAMS, of the Royal Artillery, a learned
man, and of great professional merit. Being at Quebec in some
very cold winters, among various other ingenious experiments,
it occurred to him to try the force of congelation in some of
the iron bomb-shells, which are usually fired out of mortars in
the practice of artillery ; by filling the cavity of the shell with
water, and then, having plugged up the fuze-hole, exposing it
to the cold to freeze the water, in order to find whether the ex-
pansion of the ice would be capable of bursting the shell.

THE dimensions of the 13 inch shell are as follow :

	Inches.
Outer diameter of the shell, -	12.8
Inner, or diameter of the cavity, -	9.1
Thickness of metal at the fuze-hole, -	1.5
Ditto at the bottom or opposite part, -	2.2
Diameter of the fuze-hole, -	1.7

And the dimensions are similar in the other shells. The fuze-
hole is conical, the opposite sides of which, when produced,
meet

meet at the extremity of the diameter, which passes through the middle of the hole.

HE found, that the iron plug could hardly ever be driven so firmly into the fuze-hole as to resist the force of the expansion of the ice, which pushed it out with great velocity, and a bolt or cylinder of ice, of a considerable length, immediately shot up from the hole. But when the plug was fixed in with springs, which laid hold of the inside of the cavity, so that the plug could not possibly be pushed out, the force of expansion then split the shell, and a fin or plate of ice shot out quite around.

EXTRACT from Major WILLIAM's Letter.

THESE experiments were made on iron-shells, from the 13 inch-shell to the coehorn, of 4.4 inches diameter, by filling the shell nearly with water, and driving in an iron plug with a sledge hammer.

Time. 1784.	Hour.	Barom.	Ther.	Wind.	Elev. of the fuze	Wt of plug, oz	Distance.
Dec. 21.	12 night.	29.66	— 10	Westerly.	90	35	Unknown.
22.	10 A. M.	29.69	— 3	Easterly.	90	37.25	22 feet.
23.	9 P. M.	29.80	— 16	W.	90	34.5	Unknown.
24.	11 A. M.	29.25	— 6	W.	80	39.25	62
31.	11 A. M.	29.60	— 18	W.	45	39.25	387
1785.							
Jan. 2.	5 A. M.	29.96	— 19	W.	45	41.75	415
4.	7 A. M.	29.46	— 12	W.	45	42	Burft.
9.	9 A. M.	29.35	— 4	W.	45	40.5	325

R E M A R K S.

Dec. 21.—THE fuze-axis of the shell lay nearly perpendicular to the horizon. On examining the effect, about 9 o'clock the following day, I observed the plug gone, and a cylinder of ice, of $4\frac{1}{2}$ inches high, rising perpendicularly from the fuze-hole, and of equal diameter. I searched carefully for the plug,
but

but could not find it, as there was about $3\frac{1}{2}$ feet of snow on the ground.

22.—I WATCHED this shell about an hour, when, being called out on business, I found, on my return, three hours after, the plug gone, and the icy cylinder $2\frac{1}{4}$ inches high. Plug lost.

23.—I HAD a plug made, and jagged or notched along the sides, to prevent its being forced out so easily; and watched this shell for upwards of three hours, going into the house at intervals to warm myself. The last time I went in was about half an hour after twelve, when, after a few minutes, I heard a sort of hissing sound, upon which running out, the plug was gone, and a cylinder of ice shot up, exceeding any of the former, being $6\frac{1}{2}$ inches high. Plug lost.

24.—A SIMILAR plug to the last. I watched this with more success; for although absent at intervals; yet at half past four in the afternoon, (therm. at 6°) I saw the plug suddenly forced out by the column of ice, accompanied by the hissing noise; and, observing its fall, I found it at 62 feet from the shell. The icy cylinder was 4 inches high, and the fuze-axis of the shell I found lay nearly at an angle of 80° with the horizon.

31.—CONCLUDING from the foregoing experiments, that no plug could be so fixed, as to render the resistance at the fuze-hole greater than at the weakest part of the shell, in which case I supposed it would burst, (which was the primary object in these experiments) I thought it might be worth while to observe how far the force of congelation would project a plug of a given weight and figure, and forced in with the same number of strokes of the sledge hammer. For this purpose, I placed the fuze-axis of the shell at an angle of 45° with the horizon, and on the 31st of December 1784, being the coldest day of this year, the plug was projected whilst I was absent, a cylinder was shot out, in the direction of the axis, of $7\frac{1}{4}$ inches, and not in-

clining in the least from that direction to the horizon. The plug was lost.

Jan. 2. 1785.—BEING colder than 31st December, in order to hasten the effect, I put a mixture of common salt and sal ammoniac to the water, and tied a long pack-thread, with a piece of red rag at its end, to the fuze, in order to find where it fell in the snow. This plug made its escape, like the rest; for at half past six it was flown, and a cylinder of $8\frac{1}{2}$ inches of ice standing over the fuze-hole. The plug was lost; for the red rag appeared no where on the surface of the snow.

4.—TRIED a plug made with springs, in the manner of a searcher, only very short and strong. Added the freezing mixture. The shell gave a sudden crack at a quarter after nine, and instantly shot from its surface two thin plates of ice, resembling fins, about 2 inches in the highest parts. On examining the shell I found it burst, and the plug forced up about half an inch; and, on breaking the shell, the springs were considerably bent, so as not to have recovered their first situation.

9.—REPEATED the last experiment, with a similar plug and the freezing mixture. It was thrown out, as before, and the projecting icy cylinder was $3\frac{3}{4}$ inches high.

SIMILAR experiments were afterwards made with all the lesser shells; yet, though one or more of each sort were actually burst, more plugs were projected than produced that effect. As soon as the snow began to disappear from the surface, I searched carefully for the plugs, and found six of them; which, being all marked with notches *after* the first experiment, I easily formed from them the following table.

Plug,

Plug, No. 1.	Dec. 22.	22 feet.	$3\frac{1}{2}$ to the right of the line of direction.
3.	24.	62	5 left.
4.	31.	387	$2\frac{1}{2}$ right.
5.	Jan. 2.	415	$3\frac{1}{2}$ right.
6.	4.	Shell burst.	
7.	9.	325	$4\frac{1}{2}$ left.

SUCH was the result of these experiments, from which I leave it to you to draw conclusions. I intend to pursue them again this winter; and, if you can suggest any ideas on the subject that can reach Canada before March 1786, I shall be glad to avail myself of them.

ED. WILLIAMS.

REMARKS *on the preceding Extract* by CHA. HUTTON, LL. D.

FROM these ingenious experiments, we may draw several conclusions. As,

First, WE hence observe the amazing force of the expansion of the ice, or the water, in the act of freezing; which is sufficient to overcome perhaps any resistance whatever; and the consequence seems to be, either that the water will freeze, and, by expanding, burst the containing body, be it ever so thick and strong; or else, if the resistance of the containing body exceed the expansive force of the ice, or of water in the act of freezing, then, by preventing the expansion, it will prevent the freezing, and the water will remain fluid, whatever the degree of cold may be.

THE amazing force of congelation is also obvious from the distance to which the iron plugs were projected. For, if we consider the very small time that the force of expansion acts on the plug in pushing it out, and that the plug. of $2\frac{5}{8}$ lb. weight, was projected with a velocity of more than 20 feet in a second

of time, and thrown to the distance of 415 feet by this force ; so acting, the intensity of the force will appear to be truly astonishing.

2dly, WE may hence form an estimate of the quantity which the water expands by freezing. For the longest cylinder of ice was observed to be $8\frac{1}{2}$ inches without the hole ; to this add $1\frac{1}{2}$, the thickness of the metal, or length of the hole, and the sum, or 10 inches, is the whole length of the cylinder of ice, the diameter of which is $1\frac{7}{16}$ inches ; and hence its solid content is $1.7^2 \times 10 \times .7854$ cubic inches.

BUT the diameter of the spherical cavity, filled with water, is $9\frac{1}{16}$ inches ; and therefore $9.1^3 \times \frac{2}{3} \times .7854$ is the content of the water in cubic inches.

HENCE then the content of the water is to the increase by expansion, as $\frac{2}{3}$ of 9.1^3 to 10 times 1.7^3 , or as 502.4 to 28.9, or as 174 to 10. So that the water, in this instance, expanded in freezing, by a quantity which is between the 17th and 18th part of itself.

C. H.

VI. ABSTRACT of EXPERIMENTS *made to determine the TRUE RESISTANCE of the AIR to the SURFACES of BODIES, of various figures, and moved through it with different degrees of velocity.* By CHARLES HUTTON, LL.D. *Professor of Mathematics in the Royal Military Academy, Woolwich, and F. R. S. LOND. & EDIN.*

[Read by Mr ROBISON, Jan. 1. 1787.]

1. **T**HE experiments from which the following are extracted, make part of a course, instituted at the Royal Military Academy, for determining the resistance of the air to a surface of any form whatever, either plane or curved, moved through it with any degree of velocity. I was induced to undertake these experiments, both for the improvement of my students in the Academy, and with a view to apply the conclusions derived from them towards perfecting the theory and practice of military projectiles, as well as other branches of natural philosophy, in which the pressure or resistance of fluids is concerned: Circumstances, concerning the laws of which, authors on the theory have widely differed; some making the pressure or resistance equal to the weight of a column, whose altitude is equal to the whole height due to the velocity, while others make the altitude very different, either the half or the double of that. This altitude, however, it is evident, will be various, according to the nature of the fluid, whether elastic or non-elastic, &c. or according to its different degrees of compression. I have, therefore, confined these experiments to the pressure and resistance of the air only, being that which affects
the

the accuracy of the branch, for the improvement of which I am more particularly solicitous at this time; and therefore the laws here deduced are not meant to be extended to other fluids of a different nature.

2. THE machine with which these experiments were performed, was made after the pattern of, and by the same workman as that which is described by the late excellent Mr ROBINS, in the first volume of his works, as published by Dr WILSON, and of which a view is inserted in that volume, at least of the principal parts of it. Suffice it, therefore, in this place, just to observe, that it consists of a small vertical axis, with a long horizontal arm connected with it. A body of any form is fixed on the extremity of the arm; then a fine, but strong filken thread, or cord, is wound about the axis, with a given small weight at the end, which is passed over a vertical pully, and left to descend by its weight, and so turning the axis, gives motion to the arm and body at the end of it. Hence it is evident, that a slow motion of the axis, or of the actuating weight, will give a very quick motion to the resisting body at the end of the arm; this latter being to the former indeed, as the length of the arm, measured to the centre of the body, is to the radius of the axis, which, in these experiments, was as $51\frac{1}{7}$ to 1.

3. THE actuating weight would descend continually with an accelerated velocity, were it not for the friction of the axis, and the resistance of the air to the arm and the body placed at the end of it. But this resistance always increasing with the velocity, and indeed as the square of it, it must needs happen, that, by the resistance constantly gaining on the velocity, this will soon arrive at its maximum, and after that proceed with a uniform motion, the resistance neither gaining on the velocity, nor the velocity on the resistance, but each mutually balancing the other. As soon as this happens, then the actuating

tuating weight is the measure of the resistance of the air on the body and the arm, and of the friction of the axis.

4. NEXT, to find what part of the retardation is owing to the friction on the axis, and the resistance of the air against the arm, both the actuating weight and the resisting body were taken off, and, instead of the latter, a very thin bit of lead of the same weight was put on ; then various smaller actuating weights were employed, till at last such a one was found as gave to the machine the very same degree of uniform motion as it had before, when the resisting body and the larger actuating weight were employed. Then, the degree of velocity being the same in both cases, the smaller actuating weight will be the measure of the friction on the axis, and the resistance of the air to the arm ; both of which, however, were reduced to as small a quantity as possible, the former by means of friction-wheels, and the latter by being made thin and feather-edged.

5. SUBTRACTING now the less weight from the greater, the remainder is the measure of the resistance of the air against the body alone ; that is, when reduced for the different lengths of lever, namely, by diminishing the remaining weight in the ratio of the length of the arm to the radius of the axis, measured to the middle of the thread. Thus, then, we obtain a weight which is the measure of the resistance of the air against a given surface, moving with a given velocity ; that is, a weight which is equal to the pressure of the air against the surface, or which, if it were laid upon and uniformly diffused over the surface when it is a plane, would press the surface just as much as the air does.

6. THEN, lastly, finding what altitude a column of air must have, which is of the weight of the aforesaid remaining weight reduced, and whose base is the plane of the resisting surface ; it will be the altitude of the column of the fluid whose weight or pressure is equal to the resistance, and which pressure would consequently generate the same velocity in the fluid.

7. THE

7. THE body used to affix to the end of the arm, in the following abstract, was a hemisphere of pasteboard, the hollow part being covered with a flat circle of the same, that either the round or the flat side might be made to go foremost against the air. The diameter of the hemisphere was $6\frac{3}{8}$ inches; and consequently the area of its great circle, or flat side, was 32 square inches or $\frac{2}{3}$ of a square foot, and it weighed 4 oz. 3 dr. avoirdupois. The hemisphere being fixed on the end of the arm, with either side foremost, by a medium of several times, and different ways of measuring, it was found, that the radius of the axis, including half the thickness of the thread, was 1.043 inches, and the length of the arm, measured to the centre of the hemisphere, was 53.34 inches; so that the two radii, namely of the path of the body and of the axis, are to each other as 53.34 to 1.043, or as 51.14 to 1: And therefore every experimented actuating weight must be divided by 51.14 or $51\frac{1}{2}$, to reduce it to the equivalent weight acting at the centre of the hemisphere.

8. THE times of revolutions of the arm were counted by a peculiar pendulum clock, beating seconds, which was made for the purpose. The method was thus: The clock being placed close by the machine, and the hemisphere and actuating weight fixed in their places, an assistant held the hemisphere in a particular situation by his hand, while a second assistant audibly counted the beats of the clock, beginning at 50 seconds, and counting on from 1 to 10, which consequently would end at 60 or 0; and the instant he pronounced 10, the first assistant let the hemisphere go. The consequence was, it began at first to move very slowly, and gradually increase for a short time, and then to move uniformly. The first assistant, keeping his station, called out at every time the body passed him, in its revolution, and the other assistant called out the corresponding number of seconds and half seconds beat by the clock, which I instantly wrote down with a pencil on a paper held in my hand,

hand, previously ruled for that purpose. And thus we could with ease mark the precise time of every revolution. The number of revolutions was usually continued to about 35; and as the motion, with the hemisphere commonly became uniform after two or three revolutions, and with the lead only, after about 20 revolutions, I subtracted the time of the first 25 revolutions from that of 35, and the remainder was the mean time of 10 revolutions; and, consequently, dividing by 10 gave me the mean time of one revolution very correctly; and thence, from the space of one circle or revolution, which is 27.93 feet, the velocity of the hemisphere *per* second of time.

9. IN this manner, then, by varying the actuating weight, by 1 dr. or 2 dr. &c. at a time, I obtained a long series of corresponding times and velocities, both with the round and flat side of the hemisphere foremost, and with the equivalent lead only. After which I subtracted the numbers of this latter from the corresponding ones of the two former, and the remainders, when divided by 51.14, gave the true measure of the pressure of the air at the centre of the hemisphere.

IN the following table are selected only the velocities in whole numbers of feet, namely, of 3 feet *per* second, of 4 feet, of 5 feet, and so on to that of 20 feet *per* second of time, with the corresponding actuating weights in all the three cases, namely the flat side foremost, the round side foremost, and without the hemisphere, with the lead only; namely, such actuating weights as were really experimented, and before dividing them by 51.14, to reduce them to the centre of the body.

ABSTRACT of VELOCITIES and ACTUATING WEIGHTS.

Velocity, per sec.	Weights with			Diff. or true resistances.		Ratios.
	Flat side.	Round side.	Lead only.	Flat.	Round.	
feet.	oz.	oz.	oz.	oz.	oz.	
3	3.8	2.2	1.2	2.6	1.0	2.60
4	6.2	3.4	1.4	4.8	2.0	2.40
5	9.2	4.9	1.7	7.5	3.2	2.35
6	12.8	6.7	2.0	10.8	4.7	2.30
7	17.0	8.7	2.3	14.7	6.4	2.30
8	21.9	11.0	2.8	19.1	8.2	2.33
9	27.6	13.5	3.3	24.3	10.2	2.38
10	34.0	16.2	3.8	30.2	12.4	2.44
11	41.0	19.2	4.4	36.6	14.8	2.47
12	48.7	22.6	5.1	43.6	17.5	2.49
13	57.1	26.4	5.8	51.3	20.6	2.49
14	66.2	30.6	6.5	59.7	24.1	2.48
15	76.0	35.1	7.2	68.8	27.9	2.47
16	86.6	40.0	7.9	78.7	32.1	2.46
17	98.2	45.3	8.7	89.5	36.6	2.45
18	111.0	51.0	9.5	101.5	41.5	2.45
19	125.0	57.2	10.3	114.7	46.9	2.45
20	140.0	64.0	11.0	129.0	53.0	2.44
1	2	3	4	5	6	7

HERE the first column contains the velocity *per* second; the second column contains the experimented actuating weight, with the flat side foremost; the third column that for the round side foremost; and the fourth column that for the lead only: Then the fifth column contains the difference between the second and fourth, or actuating weights for the flat side and lead; and the sixth column the difference between the third and fourth, or actuating weights, for the round side and lead only; so that the fifth and sixth columns, when divided by $51\frac{1}{2}$, will be the true measure of the resistance of the air to each side of the

the hemisphere, moving with the corresponding velocity on the same line of the first column; and in the last column are contained the ratios of these two resistances, or how often each resistance of the round side is contained in that on the flat side of the hemisphere.

10. FROM a slight contemplation of the last three columns of this table, we may easily draw several important consequences. As, *first*, From the fifth and sixth columns, it appears, that the resistance to either surface, with different velocities, is always as the square of the velocity, as near as such experiments can be expected to show.

THUS, in the fifth column, taking the resistances corresponding to the velocities of 4 feet and 8 feet, which are as 1 to 2, and their squares as 1 to 4; the resistances 4.8 to 19.1 are as 1 to 4 very nearly; and the resistances in the sixth column, namely, 2 to 8.2, are also nearly in the same ratio. And so of others.

11. *2dly*, FROM the last column, it appears, that the resistance to the flat side is to that on the round side, on an average, nearly as 2.45 to 1, or $2\frac{1}{2}$ to 1 nearly, if a medium be taken among all the numbers in the last column. But, by the theory of the resistance of fluids, we are led to expect, that this ratio would have been only that of 2 to 1, instead of $2\frac{1}{2}$ to 1, as by the experiment. Now, what this difference is owing to, may be at present difficult to determine with precision. The greater part of it may probably arise from the air differing in its nature from the perfect fluid which the theory contemplates; but some small part of it may arise from the different figure of the hinder parts of the hemisphere, though I hardly suspect that this may cause any sensible difference. I intend, however, soon to try whether it be sensible to experiments; in which I intend to employ a cylinder, to compare with the flat side foremost of the hemisphere, and a whole sphere, each of the same diameter, to compare with the round side foremost of the hemisphere. I

propose also, at the same time, to try the resistance of some other figures.

12. *3dly*, FROM any of the numbers in the sixth column, it appears, that the altitude of a column of air, whose pressure is equal to the resistance on the round side of the hemisphere, is half the altitude due to the velocity of the figure; that is, half the altitude from which a body must freely fall by gravity to acquire that velocity; and, in this instance, agreeing with the theory. Thus, if we take the velocity of 10 feet *per* second, whose resistance in the sixth column is 12.4, we shall have as $32^2 : 10^2 :: 16 : \frac{100}{64} = 1.56$ feet, which is the altitude due to the velocity 10, and the half altitude is .78; but the weight is 12.4 ounces, which being divided by 51.14, to reduce it from the axis to the centre of the body, gives .2411 oz. for the true resistance to the convex side. Now, a cubic foot of air weighs $1\frac{1}{4}$ oz.; therefore, as $1\frac{1}{4} : .2411 :: 1 : .1929$, which is the bulk of the column of air whose weight is equal to the resistance, which being divided by $\frac{2}{3}$ of a foot, the area of the base, we have .86 feet for the altitude of that column, and which, therefore, is nearly equal to the half altitude above found for the velocity, exceeding it only by about the 13th or 14th part.

13. *4thly*, BUT, from the fifth column, it appears, that the altitude of the column of air, whose pressure is equal to the resistance on the flat side of the hemisphere, is to the altitude due to the velocity of the body, as $2\frac{1}{3}$ to 2, instead of being equal, as required by the theory.

VII. OBSERVATIONS of the Places of the GEORGIAN PLANET, made at Edinburgh with an Equatoreal Instrument. By JOHN ROBISON, A. M. F. R. S. EDIN. and Professor of Natural Philosophy in the University of Edinburgh.

[Read by the Author, March 7. 1787.]

	M. T. Edin.	Apt. Lon. Plan.	Er. theor.	Apt. lat. N.	Compar.
	d. b. ' "	s. o. ' "	"	o. ' "	
1787. Jan.	12. 06. 39. 24	3. 23. 35. 17	+8	— 32. 20	4
	15. 06. 05. 11	3. 23. 27. 44	—7	— 32. 20	3
	17. 06. 13. 16	3. 23. 22. 17	+5	— 32. 19	2
	18. 06. 05. 33	3. 23. 19. 42	+2	— 32. 21	2
	20. 06. 23. 04	3. 23. 14. 24	+7	— 32. 17	4

HENCE it may be deduced, (by following the method described in a paper formerly read to this Society*) that the planet was in opposition January 13^d. 04^b. 56' M. T. Greenwich, in longitude, 3°. 23'. 32". 24" from the mean equinox, with —°. 30'. 38" north heliocentric latitude.

THE error of the theory in longitude is nearly +5", and in latitude nearly —18".

I ATTRIBUTE this error in latitude to the different manner in which I observed the declinations. I formerly observed the difference of declination between the planet and fixed star by means of a common micrometer. But I was obliged to substitute Dr BRADLEY's rhombus for my micrometer, which had received an injury which I could not get repaired in time. If this be allowed, the error in longitude will be diminished nearly 2".

My telescope has an achromatic object glass of 44 inches focal distance, magnifies 19½ times, and takes in a distinct field of 92'.

* Transactions of the Royal Society of Edin. Vol. I. N° XI. Phys. Cl.

92'. The planet was always compared with at least two stars, which passed through the field without altering the position of the instrument. The interval between the transits of the fixed stars, compared with their difference in right ascension in the tables, shows the error of the position of the horary wire; and the planet's difference in declination shows what portion of this error is to be applied to the time of its transit. When the position of the horary wire was very oblique to the horizon, and the altitudes small, a correction was made for the difference in refraction.

BOTH ends of the polar axis were firmly supported in a stone wall. The telescope turned round on a pin within two inches of the upper pivot of the axis, and close by the object glass. The other end of the telescope was supported (at the place of the wires) by a stiff rod, which turned round a pin within two inches of the lower end of the polar axis; so that the telescope, axis and this rod, formed a triangle. Another stiff rod was fastened to the telescope at the place of the wires, with a double joint, and its other end passed through a socket, firmly fixed on the side of the window, where it was held fast by a screw-pin. The rod was in a plane, nearly parallel to the equator. It is easy to see that, by this construction, each part of the instrument was exposed to a longitudinal strain alone, and all effects of the tremor of its parts were avoided. It was so completely free from any inconvenience of this kind, that, even in very boisterous winds, the image of the star was perfectly steady, and free from every kind of quivering. I never found any two comparisons of the planet with the same pair of stars differ above half a second in time. As the instrument was so exact, and did not (exclusive of the telescope) cost above three pounds, I thought that this short account of it would be acceptable to such as are not provided with those expensive instruments which are thought essentially necessary for making good and useful observations.

VIII. ANSWERS to the *Objections of M. DE LUC with regard to the THEORY of RAIN.* By JAMES HUTTON, M.D. F. R. S. EDIN. and Member of the Royal Academy of Agriculture at Paris.

[Read by the Author, Dec. 3. 1787.]

M. DE LUC, in his *Idées sur la Météorologie*, has made some objections to the Theory of Rain * which I had the honour to lay before this Society. I shall now endeavour to answer these objections; and hope the Society will forgive me for taking up a little of their time and attention with this subject. The reputation of M. DE LUC is so well established in the republic of letters, that I must not neglect remarks which have the sanction of such authority; although, in the present case, they appear to me to have come from a judge who was too much preoccupied with a different system.

THE question between us, according to M. DE LUC's own statement, is this, Whether or not, when two masses of air of different temperatures are mixed together, the humidity of the new mass is greater than the mean between the humidities which the two masses had separately? This I maintain to be a physical truth, and M. DE LUC refuses to admit it as a rule in nature.

I HAD established this proposition, That, upon the supposition of the evaporating power increasing with heat, but increasing at a greater rate, the mixture of two portions of air, of different temperatures and sufficiently saturated with humidity, would produce a condensation of water which might then become visible.

* Transactions of the Royal Society of Edin. Vol. I. N° II. Phys. Cl.

fible. I then say, That this case properly applies to the phenomena of breath and steam, which give a visible condensation in mixing with the colder atmosphere; and it explains the various appearances that may occur in mixing together several portions of air more or less saturated with humidity, and in different temperatures of heat and cold. For,

It is not every mixture of the atmospheric fluid, in different temperatures, that should, according to the theory, form a visible condensation; this effect requiring, in that atmosphere, a sufficient degree of saturation with humidity. Neither is it necessary for this effect, that the two portions to be mixed should each be saturated with humidity up to the temperature in which it then is found; it is sufficient, that the difference in the temperatures of those portions to be mixed should more than compensate the defect in point of saturation; but if a mixture shall be made of two portions of the atmosphere, both fully saturated with humidity, then, however small may be the difference of their temperatures, there is reason to believe, that a condensation proportionate to this difference will take place.

HERE it is to be observed, that I have made the rule absolute, or generalized the proposition to every supposable case; while, at the same time, I appealed to familiar examples in two cases, that is, of humid atmosphere and of pure steam, in giving the breath of animals in the one case, and the steam of a boiling kettle in the other.

THE proposition being thus made perfectly general, and concluded from experience to be a law of nature, M. DE LUC has endeavoured to refute this physical principle, by attempting to explain, in another manner, the natural appearances upon which it has been founded. It shall now be my business to show, that this explanation which M. DE LUC has endeavoured to give of the subject, is founded upon nothing but inadvertency or misapprehension.

HE

HE says, (parag. 585.) “ Je ne suis point surpris que le
 “ Dr HUTTON ait été frappé de ce que la respiration des ani-
 “ maux produit un brouillard dans l’air, lorsqu’il est humide ou
 “ froid ; j’en ai été frappé aussi, comme d’un phénomène qui
 “ ne s’explique pas par les loix ordinaires de l’évaporation :
 “ mais il m’a paru, en même tems, qu’il étoit d’une toute autre
 “ classe ; qu’il n’appartenoit pas à l’hygrologie, mais à la phy-
 “ siologie ; en un mot, que les vapeurs qui s’y manifestent, ne
 “ procèdent pas de l’évaporation d’une eau contenue dans les
 “ poumons. Ceci étant lié à quelques idées sur la nature des
 “ causes de la pluie, j’en renvoie le développement à une autre
 “ lieu, parce qu’il formeroit ici une trop longue digression, et
 “ que d’ailleurs, si j’examine les faits rapportés par le Dr HUT-
 “ TON, ce n’est que relativement à l’hypothèse fondamentale
 “ elle même, et non à ses conséquences dans la Théorie de la
 “ Pluie ; puisqu’on a vu, que cette hypothèse pourroit être ad-
 “ mise, sans que la pluie pût en être la conséquence, vu l’état
 “ ordinaire de l’air.”

As in this paragraph is contained all the objection that M. DE LUC, so far as I can perceive, is able to make against the Theory of Rain, it will be proper to examine it particularly, and divide it into the two different propositions which it contains. These are, *first*, a denial of the general principle, with regard to the condensation of humidity in the atmosphere; as not being a true principle, or properly founded ; and, *2dly*, a refusal of the application of that general principle, supposing it true, to the theory of rain. Of these, then, in their order.

WITH regard to the *first*, M. DE LUC admits all that I could possibly propose to draw from this example, *viz.* That moist air, breathed from the lungs of an animal into the colder atmosphere, produces a condensation of water, in proportion to the saturation of the atmosphere with humidity, and also to its degree of cold below the heat of the breath ; for he acknow-

ledges, that he had also been struck with that appearance, which he thought inexplicable by the ordinary laws of evaporation and condensation. But, says he, it is not to be admitted as a fact to prove the supposed proposition. Why? Because it does not belong to hygrology, but to physiology.

I SHOULD have been at a loss what to have replied to this objection, had not M. DE LUC, in some measure, explained himself in the next sentence; where he says, that the vapours which are manifested in this case, do not proceed from the evaporation of water contained in the lungs. Here, then, it is evident, that M. DE LUC leaves the subject in hand, the condensation of the breath, to enquire after the cause of its humidity. But whatever be the cause of this aqueous vapour in the breath, there is certainly no question about its effect; that is, the humidity of the warm expired air, which is to be mixed with the atmosphere, and there to produce mist. I do not, therefore, see how any argument can be founded upon this supposed operation of the lungs, whatever it be, any more than upon that of the heart, the liver or the kidneys. In our meteorological enquiry, we surely are no ways concerned about the composition or decomposition of water; a subject of chemical enquiry: We only want to explain the condensation of that humidity which is on all hands allowed to be in the breath.

THE question which, in this case, should, according to the rules of science, have been either acknowledged or denied, was this, Does the moist air, expired in breathing, form a condensation of water, in being mixed with cooler air sufficiently saturated with humidity? M. DE LUC has evaded making any direct answer to that question, in proposing to develop the subject upon some other occasion. This may have suited the convenience of our author, who was busy in forming a meteorological theory very different from that which I had proposed; but he had undertaken to disprove my proposition, with regard to the condensation of vapour; and this visible condensation of
the

the breath is the natural phenomenon which is to be explained, or the scientific experiment by which the theory which M. DE LUC refuses, is approved.

It may be proper here to observe, that I only consider the dissolving power of air with respect to water, in order to contrast it with the precipitation of the dissolved substance, when the action or effect of heat has been diminished according to the theory. It no ways concerns my proposition, whether it is upon the principle of dissolution or simple expansion by heat, that the aqueous vapour is retained in the air, or preserved in a transparent state. The expression of dissolution best answered my purpose, where the saturation of the atmosphere with humidity was to be expressed; therefore I retained it, although I had declared in this Society, when my first paper was read and conversed upon, that I did not mean in the least to enter into that question which Professor ROBISON then put. In like manner, it is absolutely indifferent to the theory, whether the inspired air or breath acquires its humidity by evaporation, dissolution, or chemical resolution and composition: Therefore, if this negation, with regard to the origin of water, be intended by M. DE LUC as an objection to my proposition, which I think has no relation with that subject, it would be proper he should show in what respect that argument of his affects the condensation of the water contained in the breath, when that breath is mixed with another portion of air.

I NOW proceed to the *second* proposition of M. DE LUC, which is, That, supposing my hypothesis admitted, it does not follow that rain happens in consequence of this cause; the ordinary state of the atmosphere being, as he alleges, too dry to admit of this effect. Now, this may be a very good reason why it should not always rain, or should not rain in that particular state of the atmosphere which is most ordinary; but I believe it will be difficult to persuade those who admit of the hypothesis, that they should not apply this principle in the case

of rain, which surely does not happen in the most ordinary state of the atmosphere, at least not in most countries, those particularly in which M. DE LUC has made his meteorological observations.

HAVING thus discussed the case of humid air or natural vapour, M. DE LUC next proceeds to consider the case of steam, or pure vapour, as he calls it. Here he says, that the mist formed above water boiling in the open air, may be explained upon another principle than that of the hypothesis from whence I had concluded that it should be so. It will be proper to give his reasoning upon the subject :

“ La vapeur de l’eau bouillante (*steam*) est pure, parce
 “ qu’au degré de chaleur de cette eau, les vapeurs sont toujours
 “ capable de supporter seules la pression de l’atmosphère. Des
 “ vapeurs presque pures, forment les bulles qui traversent sans
 “ cesse l’eau bouillante ; et ces bouffées de fluide élastique trans-
 “ parent, déplacent l’air en se dégageant de l’eau. Si ces va-
 “ peurs se répandent dans un espace qui n’aît qu’une petite
 “ issue à l’opposite de leur entrée, en amenant cet espace à leur
 “ température, elles en chassent tout l’air, et y demeurent trans-
 “ parentes ; mais dès qu’elles l’ont dépassé, et qu’elles se repand-
 “ dent dans l’air extérieur, leur courant s’y décompose bientôt :
 “ car dès la première perte sensible qu’elles éprouvent dans le
 “ degré de chaleur auquel est attachée leur existence, ne pou-
 “ vant plus supporter la pression de l’atmosphère, elles se trans-
 “ forment en un brouillard, qui se mêle à l’air environnant.”

HERE M. DE LUC considers the transparent steam, when coming in contact with the colder atmosphere, as cooled by the air, without noticing, that it proportionably heats that air by which it is cooled. This oversight in another person but M. DE LUC himself have been more excusable, had he been less conversant with the important theory of latent heat which Dr BLACK discovered

covered long ago. But first to confine our attention to the cooling of the steam, and then to explain the appearance of condensation from this cooling alone, is a species of reasoning that one would not have expected from the author of the Modifications of the Atmosphere.

THE question is not, if a body of steam, in the 212th degree of heat, mixed with a body of air, in the ordinary temperature of the atmosphere, should preserve its degree of heat, that is to say, should be cooled or not; the question is, If the mean heat of this mixed mass be sufficient to preserve all the humidity in a transparent state; or, If there shall be formed a condensation of visible mist, in this case as well as in the other, where moist and warm air was mixed with the atmosphere? Had no condensation in this experiment been formed, the principle of condensation, consequently of evaporation, could not have been extended to the case of steam, or the rule of evaporation would not have been absolute, as comprehending both the case of the atmosphere and that of water by itself; but the condensation actually taking place in the experiment, generalizes this law of nature with respect to every possible combination of water, air and heat. This condensation does not happen in consequence of the steam being exposed to any pressure which it had not sustained before, but because the heat of the mixed mass, which is the medium between the heats of the two masses, is not sufficient to preserve all the water in the state of vapour; and this is precisely what, according to the theory, the experiment is meant to prove.

BUT M. DE LUC, though he has had recourse to the cooling of the steam alone, to account for the mist which instantly appears upon the mixing of the steam and air, does not lose sight of the heat which he knows is not lost; but he brings it into action again, for the evaporation of that mist which has appeared. It is necessary to give his reasoning in relation to that subject. “ *Cependant ces vapeurs décomposées ont augmenté*

“ la

“ la chaleur de l’air, et bientôt par-là elles y subissent une
 “ nouvelle évaporation, qui les fait disparaître de nouveau.
 “ Ainsi ce phénomène rentre dans le cas général, d’une préci-
 “ pitation momentanée, suivie d’une nouvelle évaporation,
 “ quand des vapeurs, ou pures, ou mêlées à l’air, viennent à
 “ dépasser leur *maximum*, par l’action d’un air moins chaud
 “ qu’elles ; si du moins leur production n’est pas assez rapide,
 “ pour surmonter la cause de nouvelle évaporation qui naît en
 “ même tems de la nouvelle chaleur acquise par cet air.”

THE subject at present under consideration is the evaporation of that visible mist which is formed by the mixture of the steam and air ; and it is to be observed, that the general law of evaporation which M. DE LUC attacks, has been investigated by means of the visible condensation of water which had been evaporated. M. DE LUC would make it appear, that, upon this occasion of steam mixed with air, the visible condensation in the atmosphere was not formed according to the rule which here is generalized ; because, says he, that water is again evaporated by means of the heat which the steam had communicated to the air.

BUT this explanation which M. DE LUC has offered to account for the evaporation again of the visible mist, appears to be inconsistent with his theory respecting the condensation of the steam. For, if the condensation of the steam be the effect of its being cooled by the air, while the air is necessarily heated by it, How could the former state of things be restored without an assignable reason, or any known cause ? that is to say, How could the air restore to the water that heat which it had received by communicating with the steam ? or, How could the condensed steam receive from the air any heat, or rob it of that portion of heat which it had before imparted, and which is now necessarily required for its evaporation ? Here, surely, would be an effect without a cause, or a cause producing two opposite effects.

BUT

BUT though not in consequence of his theory, M. DE LUC seems to adduce that explanation in confirmation of it. Now, if this explanation should be admitted, it might tend to confirm his supposition, that the steam had been condensed, not by the medium temperature of the mixed air and vapour, as I contend, but by the air abstracting the heat of the steam, without mixing with that steam. It is, therefore, necessary, that I should answer that supposition with regard to the evaporation of the mist. But it requires strict attention to many circumstances, in order to see, in a just light, that atmospheric operation, which had led a natural philosopher to make a supposition of that kind.

STEAM, before it can be condensed into water, must communicate or transfer its latent heat (equal to 900° more than the heat of boiling water) to the body by which it is cooled or condensed; consequently, if the dissolving or evaporating power of heat proceeded uniformly with its distending power or sensible heat, the mixed mass of air and steam should still remain transparent, without producing mist or condensation. For the steam loses no heat but what the air gains; it is in the contact of those two fluids that this cooling happens; and it is in this place precisely that the condensation is produced. But there would be no condensation, if water could be retained transparent, elastic or dissolved, in the medium heat which is produced at the contact of those two bodies. Therefore, the condensation, which actually happens, proves this physical truth, that when a mass of steam is mixed with a particular mass of the atmosphere, or with a certain portion of the atmospheric fluid, the humidity of the new mass is greater than the mean between the humidities which the two united masses had separately.

I MIGHT now content myself with this observation, That it is only with the production of mist or visible vapour that my proposition is concerned, and not with the dissolution of that mist again, when it comes to be mixed with another portion of the

the atmosphere which is not saturated with humidity. But I have to show, that M. DE LUC has not reasoned accurately in explaining the re-assumption of the visible mist into the transparent atmosphere. For, though this fact has no immediate connection with the question in dispute, the condensation of vapour; yet it might be brought in to affect that question, by a sort of reasoning, which, though not scientific, would be specious.

THE mist or visible vapour, according to that reasoning of our author, is evaporated by the heated air: Therefore, that vapour ought not to have been condensed; but it was condensed; therefore it must have been condensed upon some other principle than that which I have alleged is general to all evaporation and condensation of humidity. Thus, M. DE LUC would, in effect, though not in terms, make this condensation to be no condensation, or not the condensation in question, because it is not permanent. It is evident, however, that this precipitation of the evaporated water is permanent, so long as the conditions of its condensation are continued or remain. But in this case of steam emitted into the open air, those conditions of condensation cannot continue; they must be changed, and the condensed vapour must be again evaporated, so soon as it meets with a sufficient quantity of air under-saturated with humidity. Therefore, M. DE LUC has endeavoured to explain the evaporation of the visible mist in this case, upon a false principle, by not taking into consideration the quantity of under-saturated air, which the ascending vapour meets with in the atmosphere.

THUS, whether we consider the explanation which M. DE LUC has endeavoured to give, of the condensation of mist in the case of steam mixed with a body of air, or of the evaporation of that mist again when rising in the atmosphere, there appears to be no solid reason for his objection to the theory; and I must be allowed to maintain, that here also, in the case of pure vapour, or steam mixed with a portion of the atmosphere,

sphere, the rule is absolute, or the assumed principle with regard to the particular modification of the law of heat, is perfectly confirmed, at the same time that it is generalized, in being applied to every species of vapour and atmospheric mixture.

I CONSIDERED the two examples of breath and steam as sufficient to confirm the principle with regard to aqueous condensation and evaporation, seeing that they comprehended every possible case, so far at least as the theory was concerned. But, in those examples, the appearance was only that of mist, or visible condensed vapour, which corresponded to cloud, and not immediately to rain. I therefore thought it necessary, in order to overcome the ordinary prejudices of mankind, to give an example seemingly more in point, although perhaps superfluous, as it follows so plainly from the principle. There is, however, something so convincing in the appearance, when a shower of rain is formed artificially in a chamber of experiment, that even a philosopher finds himself better satisfied, after seeing the fact, than by many arguments, by which all the steps of the operation might be explained, and every effect foretold. I therefore gave two examples of this sort, which had come to my knowledge. It is concerning these that we are now to examine what M. DE LUC has said, (parag. 587.)

“ Le seul des phénomènes cités par le Dr HUTTON, qui ait
 “ un rapport immédiat avec sa théorie, est la précipitation nei-
 “ geuse des vapeurs répandues dans l’air chaud d’une chambre,
 “ lorsque cet air vient à communiquer à un air extérieur très-
 “ froid. Mais la preuve qui semble en résulter en faveur de
 “ cette théorie, n’est qu’apparente ; car il n’y a pas lieu de pré-
 “ sumer, que les vapeurs fussent à leur *maximum* dans l’air ex-
 “ terieur, ni à Tornea, ni à Petersburg : circonstance qui nean-
 “ moins seroit nécessaire pour produire une précipitation d’eau
 “ d’après l’hypothèse ; à moins qu’on ne supposât encore, que
 “ quoique les vapeurs ne soient pas à leur *maximum* dans deux
 “ airs qui se mêlent, elles peuvent le dépasser sensiblement dans

“ le mélange ; ce qui exigeroit toujours plus des expériences directes.”

WE have already seen how M. DE LUC has endeavoured to explain the phenomenon, or rather to elude the question, when the breath which is expired into the atmosphere is visibly condensed ; but surely that was a phenomenon which had an immediate relation to the theory. Therefore M. DE LUC is by no means warranted in saying, that this one, which he is now examining, is the only phenomenon of those cited by me which has an immediate relation to the theory ; for, as the experiment of the breath exhibits the formation of cloud, and as cloud is generally considered as the immediate cause of rain, the formation of cloud without rain, in our experiments, is as immediately related to the theory, as the formation of rain without cloud. We are now to see how M. DE LUC has endeavoured to elude the force of this example of the formation of rain.

THE reason here given by our author, why the proof, resulting from these examples of actual rain, is not real, but only apparent, is this, Because, says he, there is reason to presume, that the external air in those two cases was not fully saturated with humidity or vapour. Now, for that very reason, I say, circumstances were just so much the more unfavourable for condensation ; consequently, if condensation actually takes place in this unfavourable case, *a fortiori* it must be allowed in others where circumstances may be more favourable for that operation. It is therefore evidently my interest, so far to allow M. DE LUC his supposition with regard to the state of the external air. But how that should require more proof, or more direct proof, on my part, I am at a loss to conceive ; as I think that I have, on that very account, good reason to demand of M. DE LUC better arguments, or more direct proof, against the theory. M. DE LUC, indeed, gives a reason for this demand of his, in the next sentence ; but it is a very different one from that

that which he had already given. It is this, “ Car d’ailleurs, “ les phénomènes dont il s’agit peuvent s’expliquer sans avoir “ recours à cette hypothèse.” Here, indeed, is a very good reason for objecting to the application of those experimental cases ; and now we are to examine this explanation which M. DE LUC is to give of the phenomenon.

He says, “ La masse (comparativement fort petite) de l’air de “ la chambre, perdoit très-promptement une quantité sensible “ de sa chaleur par l’ouverture qu’on y faisoit, sans que l’air “ extérieure se réchauffât sensiblement à cette ouverture, après “ de laquelle l’air qui commençoit à s’échauffer, faisoit bientôt “ place à de l’air froid, en s’élevant. Les vapeurs chaudes de- “ voient donc se précipiter en brouillard dans la chambre ; par- “ ceque l’air extérieur n’en recevoit presque point.”

THE explanation which M. DE LUC has here attempted, either is not conceived with that distinctness of idea which is required for investigating the laws of nature, or is not expressed in such precise terms as might make it easy to bring his proposition to a scientific issue, in applying principles. Let us, however, endeavour to follow the argument of our author through the obscurity in which it is involved.

M. DE LUC says, that the air of the chamber would quickly lose a sensible quantity of its heat, without the external air being sensibly heated at this opening. Does he mean, that the air of the chamber would suffer any loss of its heat upon this occasion, besides what happened by the interchanging of the external and internal air ? Such a supposition as that might truly form the foundation of an argument ; but this, it is found, will not conform to the laws of hydrostatics. He, therefore, must be obliged to suffer some of the heated air to escape, and its place to be supplied with the cold air which comes in. Things being in this state, our author says, that the warm vapours ought to precipitate, in forming mist in the chamber, because the external air receives scarce any of them. This evi-

dently is to have again recourse to the fallacious argument, already discussed, of a cold body cooling a warm body, without being warmed; and it is to suppose a shower of snow produced in the warm air of the chamber, by the introduction of cold air, without that cold air mixing with the warm. But how is one body of air suddenly to cool another body of air, without their mixing together? At least, it is as natural for those two bodies to be mixed together as to form a medium temperature; and if M. DE LUC is to found an argument upon any of those events not happening in that manner, he should point out some other reason for his supposing that they do not mix, than that of their forming a condensation of humidity; an event which should happen, according to the principle we have endeavoured to establish; a principle which M. DE LUC would persuade us to believe to be without foundation.

OUR author then forms the supposition of another state of the case, in order, no doubt, to put things in a clearer light; but, without more accurately attending to the circumstances of the case than he has done, it has no other effect, in my opinion, than to perplex the subject more and more. He says, “ Si au lieu d’une simple ouverture à la chambre, ses parois eussent été enlevés, et que la masse de son air eût été ainsi en contact tout le tour avec l’air extérieur, il s’y feroit aussi formé un nuage; mais alors il auroit bientôt disparu en s’évaporant, comme celui de l’eau bouillante disparoit dans l’air qui l’environne.”

HERE M. DE LUC does not seem to be sensible that he is only describing what should actually happen according to the theory. But he had just now given us to understand, that he was to explain the formation of snow or rain, in this case, upon some other principle than that of the proposition which has been now so fully considered. How far he has performed that undertaking, I would willingly leave to be decided by those who may be more impartial judges in this case. But lest it should

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be thought that I omit to answer any thing which M. DE LUC may propose in relation to this subject, I shall now examine this last statement which he has given of the case, and endeavour to show, that every thing which he supposes to appear, should truly happen according to the proposition which he has been pleased to question or deny.

IN supposing the case of a body of warm and humid air environed by the cold atmosphere, M. DE LUC does not here mention what degree of saturation or humidity he supposes in the external air. Now, upon this will very much depend the consequences of mixing the small portion of humid air with an indefinite portion of the surrounding atmosphere. If we suppose, as, from other parts of his writing, M. DE LUC inclines to do, that the atmosphere is not fully saturated, then all the appearances must follow which he has supposed; that is to say, that there is first to be a visible condensation in the mixture of the two airs; but as this compound mass, or warmed air, mixes with the colder, by rising and dispersing in the atmosphere, the condensed humidity is at last to be totally evaporated or dissolved in the quantity of air which is not saturated with vapour.

LET us now again suppose the surrounding atmosphere to be fully saturated or impregnated with humidity, then, in mixing with it the warm humid air of the chamber, there is reason to conclude, that the condensation of humidity would remain permanent, although it might not remain visible, if in small quantity and greatly dispersed in the atmosphere. But this will require some explanation.

ACCORDING to the principle assumed in my proposition, it is equal portions of the unequally heated airs, that, upon mixture, should produce the greatest condensation of humidity; and that, in proportion as a very small quantity of one or other is employed, that is to say, in proportion to the inequality of the mixed bodies, the smaller quantity of condensation will
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be produced. Now, the mixture, whether of steam or moist air, with the open atmosphere, in uniting with so much air, must soon be brought to the most extreme case of this kind, that is, to the greatest inequality of the mixed bodies, and to the smallest quantity of condensed vapour. Nevertheless, according to the rigour of the rule, no portion of warm saturated air can be mixed with cold air in the same saturated state, without there being produced a certain quantity of condensation, which will then remain permanent, so long as the proper conditions are preserved. In like manner, as two saturated solutions of a saline substance, *e. g.* of nitre, in different temperatures with regard to heat, when mixed and preserved in the same temperature, precipitate a quantity of salt, which is never reassumed by the water, unless the heat of that fluid be increased above the medium temperature which the mixture had produced. This last is a definite and a practicable experiment; the other, with the atmosphere, is an indefinite experiment which cannot be made. And I am surprised that M. DE LUC should not have seen the subject in the proper light.

IN this case of warm and humid air mixing with the colder atmosphere, as for example, the vapours coming out from the vent of a malt-kiln, it is evident to observation, that the mist which is delivered into the air disappears only in proportion as it is dispersed in the atmosphere, that is to say, as it meets with unsaturated air by which it may be dissolved. Now, this dissolution is proved by some other observations, which it is extremely easy to make. These are, *first*, that, *cæteris paribus*, it requires very little dispersion of the mist or visible vapours in the atmosphere, in order that they may be dissolved when the air is dry; and that, on the contrary, when it is moist, the vapour continues visible long after it is so dispersed. *2dly*, That it requires a less difference in the temperatures of the two mixed airs to produce a visible mist, when the atmosphere is moist than when it is more dry. So far, therefore, as this experiment

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is practicable, I think we may be allowed to say that natural appearances confirm our theory.

LONG before writing the Theory of Rain which is now in question, I had ascertained the dissolution of nitre in water, to proceed, not uniformly with the heat, but in a rate that was increasing. I had also accurately measured several of the ordinates of the curve which this progress formed, by carefully evaporating solutions saturated in different degrees of heat; and I had once some thoughts of corroborating the proposition, with regard to the rule of vapour by the measured curve, with regard to the solution of nitre. But as such analogical reasoning in physics is only proper to lead to conjecture; and as, in the case of vapour, we find the most direct proof that the rule is to increase at a growing rate with the heat, I gave nothing in my paper but what was necessary to ascertain the principle so far investigated. M. DE LUC has indeed disputed it; but any person who has read his later publications, will hardly expect, that, with his meteorological ideas, our author should, on this occasion, be altogether free of partiality.

HAVING thus answered every objection which M. DE LUC has made, it may be proper farther to observe, that it was not for want of other examples to establish the principle of heat and evaporation, that I confined myself to those which M. DE LUC has now disputed. I considered them as all unexceptionable, and as perfectly in point. I therefore thought them sufficient to establish the truth of the proposition which had been assumed. I might have referred to the mist formed in a summer evening upon meadows heated by the sun during the day, and evaporating humidity when the air grows cool; as also, to the visible smog, in the winter season, from the surface of water, a degree or two only above the freezing point, when the atmosphere upon that surface is about 15° colder. In like manner, I might have cited the experiments
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wherein condensation of vapour is formed, by mixing the atmospheric air with that which had been rarefied, or by emitting into the atmosphere air which had been condensed. In all those cases, there is the mixture of two portions of the atmosphere, in sufficiently different temperatures, to produce condensation of humidity, which actually happens. Thus, all those appearances are properly explained by the theory, or, as experiments, they confirm the assumed proposition.

BUT if thus every particular example is a proof, and if each example is unexceptionable in its kind, what degree of evidence must arise from the united testimony of every possible experiment almost which can be adduced in relation to the subject? It is to be presumed that M. DE LUC, with all his extensive knowledge of nature, could not adduce one shadow of a fact by which the alleged proposition could be called in question or disproved.

M. DE LUC concludes in the following manner, (parag. 588.)
 “ Je ne vois donc rien dans ces faits, qui contribue à éclaircir
 “ la question de la pluie; et par conséquent elle me paroît
 “ rester au point où je l’avois amené avant que d’entrer dans
 “ ce nouvel examen. Je tire même du mémoire du Dr HUTTON, ces deux conséquences, qui justifient le travail que j’ai
 “ entrepris. Quoiqu’il paroisse s’être beaucoup occupé des
 “ phénomènes de la pluie, aucune théorie à leur égard ne l’avoit
 “ satisfait; et d’après ce qui lui étoit connu des loix de l’hygro-
 “ logie, il avoit conclu, que la précipitation de l’eau simple-
 “ ment évaporée, ne pouvoit être produite que par refroidisse-
 “ ment. Or, ce sont, entre autres, ces deux motifs qui m’ont
 “ conduit dans mes recherches.”

M. DE LUC had no occasion to justify his undertaking by any opinions of mine. His writings will always contain matter sufficient to interest the public; and his ideas of hygrometry must be supported upon their own bottom. I therefore wish he had not given as my ideas expressions which, however,
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in some respects, sufficiently just, may bear perhaps another interpretation. That the precipitation of water simply evaporated cannot be produced except by cooling, is an expression which, though not contrary to my idea, does not contain precisely my opinion. Water is not precipitated from the atmosphere in time of rain by the cooling of the air, in the ordinary sense of that expression, that is, by the abstraction of a certain quantity of its heat, which is then communicated to some other body ; but it is because the air is not able to contain so great a quantity of water, in proportion to its heat, when it is in a lower temperature. The compound mass of air, which in the formation of rain precipitates water, is not cooled, so far as I know, below the mean temperature of the different masses of unequally heated air which have concurred to form it ; but this mean temperature does not suffice to evaporate all the water which had been contained in these masses separately. This, however, is only by the by ; and I now proceed to the material part of his conclusion, where he thus continues :

“ QUANT à l'hypothèse que je viens d'examiner, elle étoit
“ très naturelle dans l'état des faits connus ; puisqu'il n'étoit
“ pas possible de concevoir d'aucune autre manière, que des
“ mélanges d'airs à différentes températures, pussent produire
“ des pluies abondantes : et la vraisemblance de cette hypothèse
“ ne pouvoit être détruite, que par un genre d'expériences et
“ d'observations, qui ne fait que de naître en physique avec
“ l'hygromètre.”

IN answer to this, I have but to observe, that, had M. DE LUC contented himself with saying, as he here has done, that the probability of this hypothesis could not be overturned, but by a sort of physical experiments and observations which have just taken their birth with the hygrometer, I should have waited patiently until those experiments and observations had arrived at that maturity which might enable them to confute my theory. But M. DE LUC has undertaken to confute it upon

other principles, which do not require any profound knowledge of that instrument. It is only to these that I have answered ; and I beg it to be understood, that the theory which I have endeavoured to establish, is just now as open to the experiments of the hygrometer, whether for being supported by them or overthrown, as if nothing had been written upon the subject.

IX.

IX. *An ACCOUNT of a DISTEMPER, by the common People in England vulgarly called the MUMPS. By ROBERT HAMILTON, M. D. Fellow of the Royal College of Physicians, F. R. S. EDIN. and Physician at Lynn Regis, in Norfolk*.*

THE mumps, or what I beg leave to call angina maxillaris, is an epidemic disease of a very singular nature. It has appeared sometimes to be pretty general; but this has not been the case for many years in this place. It seems to be analogous to, if not the same distemper with that called the branks, by the common people in Scotland. In the general account of epidemics, in the first volume of the Medical Essays of Edinburgh, a disorder is mentioned which seems to have been a slight degree of that which is the subject of the following paper. I have had much practice in this disease, and indeed was once reduced to the utmost danger by it myself.

IN the following paper, I shall not pretend to give a systematic treatise on the mumps. I shall relate what was the result of observation, both in regard to the history and cure of this disease; and as I shall faithfully detail what I actually saw, I flatter myself, that this account will not be unworthy of the perusal of future observers.

* This paper was read before the Philosophical Society of Edinburgh, August 5. 1773. It is now printed by order of the Committee for publication of the Transactions of the Royal Society of Edinburgh.

THE history of the mumps is as follows :

A LASSITUDE, a heaviness, a general restless uneasiness, not easily described, are perceived several days before the swelling which characterises the disease, begins to appear. These disagreeable feelings are attended with gentle rigors, and some degree of fever, which, being slight, is commonly disregarded. Then a stiffness, with obtuse pain, is felt in one or both sides of the articulation of the lower jaw, impeding its motion and of course mastication ; which symptoms increasing, a swelling appears upon the parts the following day, and quickly extends to the parotid glands, the neighbouring skin, and cellular membrane. Here, in some, it stops without discolouring the skin ; and, by keeping the parts moderately warm, and cautiously avoiding the cold external air, the patient is soon freed from it, without any medical assistance. But, when this is not the case, the parts affected generally redden the next day, the tumor becomes more diffused, and sometimes increases so suddenly in size, that, on the third day from its first appearance, it occupies the salivary glands and surrounding cellular membrane on that side ; and, if both sides are affected, the parts are so much swelled, and the tumor descends so low, that the countenance is rendered of a frightful enormous magnitude ; and now deglutition becomes more or less impeded. All this is frequently without much pain ; but most commonly there is now a great deal, and a considerable degree of fever. When this happens, the countenance appears florid, and a dusky erysipelatous inflammation covers the tumor, which is deepest in colour where there is the greatest hardness, *viz.* on the parotid and maxillary glands. In many subjects here it ends. And it seems probable from the natural resolution of the disease, which now immediately follows, that the tumor has attained its greatest magnitude,

nitude, and the distemper its acmé ; for, about the morning of the fourth day from the first appearance of the swelling, a discharge begins from the emunctories behind the ears ; a dew-like sweat, frequently in large drops, issues from every pore of the extended surface of the tumor ; a gentle diaphoresis covers the body, if in bed ; the inflammation abates, the swelling gradually lessens, and, with these favourable circumstances, the fever goes off, and the distemper totally disappears about the sixth day, if nature is not interrupted in her business. But, if the tumor subsides suddenly about the fourth day, and one or both testicles begin to swell, sometimes with much pain, heat, inflammation, new rigors, and a fresh exacerbation of fever, much is to be apprehended from this new morbid appearance, and much circumspection is required in the treatment of it. For the means employed by nature to promote the resolution of the tumified testes, are exactly similar to those which take place in the termination of the tumors below the ears ; a spontaneous discharge issues from the skin of the parts affected, and, if this is copious and continued, and accompanied with a free perspiration from the surface of the whole body in bed, the disease ends happily without farther trouble ; but if it is scanty, partial, or interrupted by accidental cold or imprudent treatment, the tumors of the testicles subside suddenly, the patient becomes restless, a fresh exacerbation of fever ensues, the head is affected, delirium follows, with convulsions and other dreadful symptoms, and sometimes death closes the scene.

IT may be asked, Whence does this train of symptoms arise ? Is it from a tumefaction of the brain taking place in the instant of the sudden diminution of the tumors of the testes ; as we have before seen happen to the testicles, when the salivary glands suddenly subsided ?

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AN extraordinary circumstance took place in two cases which came under my notice. One testicle in each person was found to be wasted away after the disease had ended; some particulars of which shall be mentioned in the sequel.

THE pathognomic signs of the mumps may be readily gathered from the foregoing history, and are the same with little variation. The characteristic tumor under one or both ears, involving the salivary glands, with more or less of a concomitant fever, is the first. If the disease is mild, it soon ends by a spontaneous sweating from the surface of the tumor. If not, that tumor (or tumors, if on both sides) subsides suddenly, accompanied with a fresh exacerbation of fever, and the testicles swell. And here it also sometimes goes no further, but terminates by a discharge from the skin covering those parts. But if the testes suddenly subside, and a fresh exacerbation of fever appear at the same time, the brain is immediately affected, attended by a train of terrible symptoms, and death sometimes ends the conflict.

THE mumps, so far as my observations extended, appeared generally confined to young men, from the age of puberty upwards to thirty years. Not many between thirty and forty fell under my care. I never knew above one man of forty attacked by this disease, and he suffered severely. Very few boys were affected, and those had the distemper mildly.

I NEVER saw any of the female sex above ten years old subject to this illness; and those who fell under my care were not numerous, and generally had the disease mildly. I do not remember one instance of the *mammæ* being affected. I have, however, heard of this circumstance; but cannot speak as to the authenticity of my intelligence. But from what happens in men, it is, from analogy, most natural to suppose, that the ovaria are more likely to be affected than the *mammæ*; although there is undoubtedly a wonderful sympathy between

tween the uterus, and we suppose its appendages, and the mammæ. On this matter, however, I shall not pretend to decide.

THE mumps made its appearance in an epidemic form at Lynn in 1758, and remained several years afterwards. It was chiefly confined to the spring months. In the year 1761, it prevailed very much. Two companies of the Norfolk regiment of militia were quartered here, and put under my care. It raged more among these soldiers, in proportion to their number, than amongst the inhabitants of the town. I was very seldom without seven or eight of these men upon my list, ill of the mumps. After 1761, it began to decline. It, however, made its appearance in spring and autumn, more or less as an epidemic, for several years afterwards; but the number afflicted with it became gradually less: And some sporadic cases were to be met with many years after the epidemical appearance of it had ceased.

IT must be ingenuously confessed, that on the first appearance of this (to me) new disease, I was much at a loss how to treat it. In vain I searched in many authors for its history and cure. That short account given by Mr GOOCH, in his *Cases and Remarks in Surgery*, published first about this time, was the only one I could find; and that was too defective to form from it any general method of cure of a disease much more formidable in its appearance here, than that mild species of it which seemed to have fallen under his care, and gave way so readily to the antiphlogistic method of cure. Observation soon taught me that this plan was not only insufficient, but hurtful; and that large evacuations, with a view to reduce the tumors and promote their discussion, did oftener harm than good; the changes which take place in a bad kind of this disease, from the salivary glands to the testes, and from these to the brain, appearing to be more frequent and dangerous, when evacuations were freely
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and copiously employed, than when they were sparingly used, or not at all. Thus disappointed by following the only method of cure I had seen, I determined to study the disease with attention, and endeavour to imitate nature's operations in removing it; and had the satisfaction to see all my patients recover. As the antiphlogistic method had not been attended with success, I avoided bleeding, unless it was indicated by an uncommonly hard and full pulse, attended with great inflammation and pain; and even then I bled but sparingly. Indeed, as highly inflammatory symptoms but rarely occurred, there was seldom occasion for this evacuation. The bowels were kept open by clysters; and sometimes a gentle eccoprotic was necessary for this purpose, but the stronger cathartics were never used. As the discharge behind the ears, and the sweating from the surface of the tumor, seemed to point out nature's principal resources in terminating this disease, these were carefully encouraged, by wrapping the parts in flannel; and, if these discharges happened to stop, or even to lessen, with an increase of feverish symptoms, blisters were applied behind the ears, sufficiently large to descend from thence over the whole surface of the tumors, which, by opening a discharge from the parts immediately affected, imitated, in some degree, that evacuation from them which nature establishes to relieve herself; and by the influence of their irritation, the disease seemed to resume afresh its seat in the salivary glands, when it had in part left them, and taken possession of the testes. It was curious to observe this fact. Sometimes, after the subsiding of the tumid salivary glands, they have become swelled and painful again. When this occurred, the tumors of the testicles became less painful, more relaxed, and lessened in size, whilst the brain, at the same time, remained perfectly free from disorder. And this happened more than once in the same person. It was sometimes observed, that, after the affection of the brain had
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taken place upon the sudden diminution of the testicles, that the latter have again become tumid and painful, and that the brain, on this appearance of the disease in them, has been immediately relieved. Of this curious circumstance, I have seen several instances; but one was remarkably striking in a particular friend, to whom it occurred twice. He, however, did well; but one testicle wasted away. Reflecting, soon after this paper was first written, (which was several years after my observations were begun) on the extraordinary aptitude of this disease to fluctuate in this manner, I conceived that it would be an object of the first consequence, to fix the distemper, if possible, in its first situation, the salivary glands, until it was perfectly ended, and prevent this dangerous disposition of it, to shift its abode. An early irritation on the parts, and discharge from the surface, appeared, from what had been observed of the disease, and its mode of termination, naturally to be the most likely means of effecting this; and blisters, from what already had been experienced, seemed to be best calculated for this purpose. There could be no hazard in the trial. With this view, blisters of a size sufficient to cover the skin of the tumors, supposing they should afterwards attain any considerable magnitude, were applied over the salivary glands, before the swellings had arrived at their height, or any spontaneous discharge had appeared; and so far was the experiment attended with success, that I do not remember a single instance of a swelling of the testicles taking place, where this mode of attempting to keep up the tumefaction of the salivary glands, and anticipating the natural discharge, was put in execution. Wherefore, it became my constant practice afterwards, to apply large blisters on the tumors as soon as they were sufficiently formed to characterise the disease; and I had great satisfaction in observing their utility. From analogy, we may presume, that a similar mode of practice would be attended with the most beneficial effects, in

cases where the tumefactions of the testicles suddenly subside, and the brain becomes affected. I never had occasion to try this ; but I am so convinced, that, in cases of this kind, (where there is generally danger), it would be of the greatest advantage, that I should not hesitate a moment in covering the whole scrotum with a blister, or rather a blistering cataplasm, as soon as the least symptom of the head's becoming disordered appeared, with a view to recal (if I may use the expression) the disease from the brain to the testicles, whilst, to relieve the latter, epispastics should, at the same time, be fully employed over the tumefied salivary glands.

As the patients were generally relieved by a spontaneous sweating in bed, diaphoretics of spiritus mindereri, &c. with warm drinks, assisted to keep up the discharge for a day or two, and the distemper was soon at an end. If, about the third day, the testicles began to swell, without any remarkable increase of fever, the same method relieved them. But, if this was accompanied with a low running quick pulse, and restlessness or anxiety, more epispastics were applied, and the vis vitæ kept up by neurotic cordials, beside sudorifics, with a necessary proportion of the best of all cordials, wine, and a plentiful sweating was encouraged. The medicines employed were various, according to circumstances ; and were composed of camphire, volatile alcali, sp. mindereri, vin. antimonial. decoct. serpentar. &c. with a requisite proportion of opium to abate the restlessness. The tumefied testicles were suspended in a bag-truss ; the colon was emptied by clysters, if the patients were costive ; and, with this treatment, the patients generally got well about the sixth, seventh or eighth day.

It is requisite here to observe, that although the parts affected were kept warm, and the body covered so as to encourage a discharge from the skin, it was necessary that the lungs should have a frequent supply of cool fresh air ; for which purpose, the

the curtains of the bed were kept open, and a free ventilation occasionally admitted by the door and windows of the chambers of the sick, which had very beneficial effects.

IN the spring of the year 1758, a gentleman of about twenty-two years of age, (of this town), of a plethoric habit, was seized with the mumps. The tumors of the parotid and maxillary glands were large, hard and inflamed, and accompanied with much fever. He was bled copiously, and took a brisk cathartic, which produced very frequent and large evacuations. The tumors suddenly subsided, and his testicles as suddenly swelled to an enormous size, attended with great pain and much fever. Unfortunately, the last tumefaction was suspected to arise from a venereal cause. The event fatally proved the contrary. In consequence of the opinion of its being venereal, plentiful evacuations were deemed necessary; and accordingly bleeding and brisk purging were again repeated. The catastrophe was dreadful: For the swelled testicles subsided suddenly the next day, the patient was seized with a most frantic delirium, the nervous system was shattered with strong convulsions, and he died raving mad the third day after. My affairs calling me abroad prevented my being present on this occasion; but, on my return, at the end of the same year, I received this account from a late learned and worthy physician *, who attended the patient the three last days of his disease.

I HAD not many instances where the brain was affected. One, however, of a gentleman, in April 1762, was marked with a circumstance so extraordinary, that I beg leave to give some account of it. This person was about forty years of age, of a full habit, and had been bled some days before any symptom of the mumps appeared. He was obliged to travel a journey in a chaise, the second day after the parotid glands began to swell. On the day following this, the tumors of the salivary
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* DR. JOS. TATLER.

glands had greatly increased, were inflamed, and the patient had much fever. On the morning of the fourth day, the swellings were very much enlarged, and the testicles began to be affected with pain; on the evening of that day, the right one swelled. On the fifth day, both testicles were much tumefied; but the right one was by far the most so, and soon became twice the size of the other; and the salivary glands were found to be very considerably diminished. On the day following this, the testicles were found lessened in size, and the patient was become restless, delirious, with much fever, and had passed a very bad night; yet the testicles did not speedily, nor altogether, subside after the delirium began. Large blisters, nervous, &c. medicines, with strict confinement in bed, agreeable to the mode of cure before mentioned, soon relieved this patient; the testicles swelled again, the delirium left him, the fever went off, and the disease gradually ceased. The most remarkable circumstance attending this case was, that the right testicle, which was twice the magnitude of the other, and was the first attacked, was found, after the tumors in both had subsided, and the disease was at an end, to be reduced to almost half its natural dimensions, and kept gradually wasting, till at length a mere empty bag, consisting of the coats, only remained. The glandular body of the testicle has been long gone; neither is the epididymis at this time (April 1789) to be felt; the empty tunics are mostly flaccid, but sometimes they contract into a flattened body of an oblong shape, somewhat like an almond. This body is very tender, and gives pain when inadvertently pressed, or touched with roughness; which pain strikes in the instant up the spermatic chord to the loins, and is exquisite for a few seconds. This, however, seldom happens, as he is particularly careful to defend this very sensible and irritable part from injury; the spermatic chord is contracted and feels hard to the touch; but this also is extremely sensible. From all which circumstances,

circumstances, it may be presumed, that the vessels are much lessened in diameter, and perhaps the spermatic artery is become impervious; but the nerves have acquired more sensibility and irritability. After his recovery, he found no other inconvenience from this extraordinary change than what we have named; has had two children since, one born in 1769, and the other in 1772, who have both healthy constitutions; and he now enjoys as good health as most men at his time of life.

ANOTHER case of a wasted testicle in consequence of the mumps, came afterwards under my inspection.

A YOUNG man, of twenty-five years of age, of a healthy constitution, was, in the end of the year 1769, attacked by this distemper. Upon the tumid salivary glands subsiding suddenly, the testicles became affected. One of them was much more swelled than the other, and was found, when the swelling was reduced, to be diminished more than one half of its natural size, at which it remained in August 1771.

OF the great number that fell under my care, there was but one case which terminated in suppuration. This was a young militia soldier, of about nineteen years of age, in the year 1761. The tumor was on the left side, of an enormous magnitude, reaching from about an inch above the mastoid process to the shoulder. It was opened by incision, and about two pints of matter were discharged. The seat of it was entirely in the cellular membrane, no suppuration having taken place in the salivary glands themselves. There were large sloughs of the morbid cellular membrane separated from the vast cavity of this abscess; the loose integuments united after this very soon to the parts beneath, and the man got well in a short time.

ABOUT the end of the year 1762, the learned and ingenious Dr RUSSEL's *Œconomia Naturæ in Morbis Glandularum*, fell into my hands. There I was pleased to find an account of the
mumps,

mumps, and glad to see my observations somewhat corroborated by such an authority. He thinks it contagious,—“ *Angina hæc ex epidemicis una est, et contagiosa, et per totas domos grassari solet, nisi antea fortasse juvenes eodem morbo laboraverint.*” The last part of this sentence implies an opinion that people are not liable to have this disease more than once. I do not remember an instance of a person’s having it a second time. I have seen it go through a family of several children, which inclined me to think it contagious; but when I had the disease, not any one else in my family, which consisted of four children and six adults, was attacked by it, although my case was a very bad one. About twelve months after my recovery, one of my daughters, about six years old, had the disease, and all the rest escaped. And what is still more remarkable, I do not remember an instance, in the families where the militia soldiers ill of this distemper were quartered, of a single person’s being infected by them.

Dr RUSSEL, p. 116. relates a case of a patient destroyed by the mumps, nearly similar to that given in this paper.

HIPPOCRATES, sect. I. book I. of his Epidemics, appears to have described the mumps. I shall take the liberty to transcribe the passage from Dr FREIND’s translation.

“ *MULTIS vero aurium tumores subnascebantur, qui in alteram partem vergebant, plerisque etiam in utramque, iisque febre vacuis et in erectum stantibus nec decumbentibus, etsi nonnullis paulisper incalescerent; omnibus absque noxa extincti sunt, neque cuiquam, velut ii, qui alias sui ortus causas habent, suppurationem fecerunt. Horum autem ea fuit natura, ut molles et laxi essent, magni, diffusi aut sparsi, sine inflammatione et dolore. Omnibusque sensim et sine ulla significatione evanescerent. Fiebant ista quidem adolescentibus, juvenibus, ætate florentibus, atque horum plurimis qui in palæstra, et gymnasiis exercebantur; mulieribus vero pau-*
“ *cis.*

“ cis contingebant. Multis tusses aridæ et inanes, quibus cum
“ tussi nihil educebatur, nec ita multo post voces raucescebant.
“ Quibusdam vero ex temporis intervallo inflammationes cum
“ dolore in alterum testem erumpebant, quibusdam etiam in
“ utroque. Alii quidem febribus corripiebantur, nonnulli
“ vero sine febre persistebant. Atque adeo hæc ipsa plurimis
“ gravia et molesta fuere. De reliquo autem quod ad ea
“ attinet, quæ ad chirurgiam spectant, in his inculpate habebant.”

THE spring of the year 1761 was very cold and wet ; and those young militia soldiers, who were most liable to this disease, were out early and late in the low damp grounds adjoining this town, to learn their manual exercise ; which corresponds with this passage, “ Fiebant ista quidem adolescentibus, juvenibus, ætate florentibus, atque horum plurimis, qui in palæstra, et gymnasiis exercebantur.”

TISSOT, in his *Avis au Peuple*, when treating of diseases of the throat, mentions a distemper which is common in Switzerland, called by the French *Les Oreillons*, ou *Les Ourles*. This is a swelling of the salivary glands, particularly the parotids and maxillaries, and appears to be a mild species of the mumps. The tumor is sometimes so large as to cause a difficulty in swallowing, and also to prevent the mouth from opening without pain. Children are more liable to it than adults ; but as it is seldom attended with fever, no medicines are required. All that is necessary is, to protect the parts from the air, apply a soft poultice, to live abstemiously, especially in respect to animal food and wine, to drink a weak warm beverage, and promote perspiration. He says he cured himself in four days, with balm tea, one fourth of milk and a little bread in it. He does not mention any swelling of the testicles ; therefore this probably did not happen in Switzerland, as it never does in very slight cases of this disease.

I BEG leave to conclude this paper with the following words of CELSUS :

“ SÆPE vero etiam nova incidere genera morborum in quibus nihil adhuc usus ostenderit. Ut ideo necessarium fit animadvertere, unde ea ceperint ; ceu fine quo nemo mortalium reperire possit, cur hoc, quam illo potius utatur.”

X. A BOTANICAL and MEDICAL ACCOUNT of the
QUASSIA SIMARUBA, or Tree which produces
the *Cortex Simaruba*. By WILLIAM WRIGHT, M. D.
F. R. S. LOND. & EDIN. and Physician-general in Ja-
maica*.

An Historical Account of the SIMARUBA BARK.

THE first knowledge we had of the cortex simaruba was in the year 1713. Some of it was sent to France to M. LE COMPTE DE PORCHARTRAIN, the Secretary of State, as the bark of a tree, called by the natives Simarouba, which they employed with good success in dysentery.

IN 1741, M. GEOFFROY, in speaking of this bark, says, "Est cortex radice arboris ignotæ, in Guiana nascentis, et ab incolis simarouba nuncupatæ: coloris est ex albo flavescentis, nullo odore præditus, saporis subamari, lentiscentibus fibris constans, candido, levissimo, insipidoque, radicum, stipitum, truncique ligno hærens, a quo facile separatur."

IN 1753 and 1760, LINNÆUS makes the simaruba to be a species of pistacia, or the terebinthinus major, betulæ cortice, fructu triangulari of Sloan. Jam. 289. t. 99.

IN 1756, Dr PATRICK BROWNE published his Civil and Natural History of Jamaica. At page 345. he describes the terebinthinus, or birch and turpentine tree. The bark of

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* This paper was read before the Philosophical Society of Edinburgh, August 6. 1778. It is now printed by order of the Committee for publication of the Transactions of the Royal Society of Edinburgh.

the roots, (says he), is thought to be the fimarouba of the shops.

IN 1763, LINNÆUS makes the fimaruba to be the *bursera gummifera*, and refers to the pistacia of former editions of the *Species Plantarum*; and to SLOAN and BROWNE, as above cited. In the appendix, a reference is made to the *terebinthinus Americana polyphylla*. Commelin. Hort. 1. p. 149. and to CATESBY's gum elemi tree.

M. JACQUIN visited all the West India islands, and made many discoveries of new plants. He examined the roots of the *bursera gummifera*, and found their bark very different from the fimaruba bark.

IN 1772, I employed all my spare hours in examining the plants of Jamaica. In this delightful walk of science, I discovered and ascertained many hundreds of new plants which had escaped the diligence of former botanists. Amongst others, the tree which produces the fimaruba bark.

IN 1773, specimens of the fructification were sent in spirits, accompanied with a botanical account of the tree, to my late worthy friend Dr HOPE, Professor of Botany in the University of Edinburgh; also some dried bark from the roots. The following year, specimens, with similar description, were transmitted to my late learned and valuable friend Dr JOHN FOTHERGILL of London; who sent them to the celebrated LINNÆUS at Upsal, as appears by Professor MURRAY's *Apparatus Medicaminum*, vol. iii. p. 458. *, article Simaruba. Dr FOTHERGILL caused elegant drawings to be made of this plant; and these drawings I now have the honour of presenting to the Royal Society of Edinburgh.

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* *QUALIS* vera ejusdem arbor sit, jamjam aubletii indagine cognoscimus, ut tamen et mihi monere incumbat. b. LINNÆAM equitem, litteris jam anno 1776, ineunte mihi datis, antiquam aubletii elegantissimum opus illi innotesceret. significasse, Simarubam *Quassia* species a se haberi. Ille autem simarubæ cortex quo Cl. WRIGHT, arborem in Jamaica, vulgarem vestitam esse innuit; pariter in alvi profluviis efficaci, &c.

It is here proper to remark, that this paper was read before the Philosophical Society of this place, and committed for publication in 1778. At the time when that Society obtained the Royal Charter, I chanced to be abroad. On my return to Edinburgh, I withdrew the communication to correct and add to my account of this important article of *Materia Medica*.

Description of the Tree.

THE tree now to be described is common in all the woodlands in Jamaica. It grows to a great height and considerable thickness. The trunks of the old trees are black and a little furrowed. Those of the young trees smooth and gray, with here and there a broad yellow spot.

THE inside bark of the trunk and branches is white, fibrous and tough. It tastes slightly bitter. On cutting or stripping off this bark, no milky juice issues, as has been mentioned by various authors.

THE wood is hard, and useful for buildings. It splits freely, and makes excellent staves for sugar hogheads. It has no sensible bitter taste.

THE branches are alternate and spreading.

THE leaves are numerous and alternate. On the upper side, they are smooth, shining and of a deep green colour; on the under side, they are white.

THE flowers appear about the beginning of April. They are of a yellow colour, and placed on spikes beautifully branched.

THE fruit is of that kind called a drupa, and is ripe towards the end of May. It is of an oval shape, is black, smooth and shining. The pulp is fleshy and soft; the taste a nauseous sweet. The nut is flattened, and on one side winged. The kernel is small, flat, and tastes sweet.

THE natural number of these drupæ is five on each common receptacle; but, for the most part, there are only two or three; the rest abort by various accidents.

THE roots are thick, and run superficially under the surface of the ground to a considerable distance. The bark is rough, scaly and warted. The inside when fresh is a full yellow, but when dry paler. It has but little smell. The taste is bitter, but not very disagreeable. This is the true *Cortex Simarubæ* of the shops.

THIS tree is known in Jamaica by the names of Mountain Damson, Bitter Damson and Stave-wood. The shops are supplied with this bark from Guiana; but now we may have it from our own islands at a moderate expence.

ON examining the fructification, I found this tree to be a species of *Quassia*. Under that name, I sent it to Europe, and LINNÆUS adopted it into his system.

THERE are male flowers on one tree, and female flowers on another; and this is invariably the case in Jamaica.

Sensible Qualities of Cortex Simarubæ.

I CAN discover no astringency in the cortex simarubæ, either by the taste, or by the various tests to which I subjected it. Nor is there any mucilaginous quality to be perceived in the recent bark, or in the decoction of that which has been dried.

Its Medical Virtues in general.

MOST authors who have written on the simaruba, agree, that in fluxes it restores the lost tone of the intestines, allays their spasmodic motions, promotes the secretions by urine and perspiration, removes that lowness of spirits attending dysenteries, and disposes the patient to sleep; the gripes and tenesmus are taken off, and the stools are changed to their natural colour and.

and consistence. In a moderate doze, it occasions no disturbance or uneasiness; but in large dozes it produces sickness at stomach, and vomiting. Negroes are less affected by it than white people.

Preparation of Simaruba Bark.

THE simaruba bark yields its qualities to water, either in cold infusion or in decoction. I prefer the latter. Physicians have prescribed the bark in different quantities; but it seems now agreed that the following proportion is the best:

Two drams simaruba bark, boiled from twenty-four ounces of water to twelve ounces, then strained.

THIS is divided into three equal parts, and the whole taken in twenty-four hours.

WHEN the stomach is reconciled to it, three drams may be boiled in the same quantity of water, and taken as above mentioned. Some join aromatics to the decoction of this bark; others give a few drops of laudanum with each doze. The decoction is to be drank daily till the disorder is cured, which sometimes happens in a few days, and at other times it may require weeks to perfect a cure.

Of the Effects of Simaruba in particular Diseases.

HAVING thus treated of the simaruba in general, I am now to mention its use and effects more particularly in different diseases, and first in the Dysentery. In the years 1718 and 1723, an epidemic flux prevailed in France, and swept off a great number of people of all ages and of both sexes. This disorder not only resisted all the medicines given, but was aggravated by small dozes of ipecacuanha, the mildest purgatives, and all astringents. The disorder was happily cured by the simaruba.

M. JUSSIEU used this bark for fifteen years in obstinate dysenteries with great success; and continued its exhibition, although the catamenia in women, or hæmorrhage from piles in men, occurred during the cure.

MODERN physicians have found from experience, that this medicine is only successful in the third stage of dysentery, where there is no fever, where too the stomach is no way hurt, and where the gripes and tenesmus are only continued by a weakness of the bowels. In such cases, Dr D. MONRO gave two or three ounces of the decoction every five or six hours, with four or five drops of laudanum; and found it a very useful remedy.

THE late Sir JOHN PRINGLE, Dr HUCK SAUNDERS, and many others, prescribed the cortex simaruba in old and obstinate dysenteries and diarrhœas, especially those brought from warm climates. Fluxes of this sort, which were brought home from the sieges of Martinico and the Havannah, were completely and speedily cured by this bark. The urine which, in those cases, had been high coloured and scanty, was now voided in great abundance, and perspiration restored. Dr JAMES LIND at Haflar Hospital, says, That the simaruba produced these effects sooner, and more certainly, when given in such quantity as to nauseate the stomach. Dr HUCK SAUNDERS remarks, That if the simaruba did not give relief in three days, he expected little benefit from its farther use; but others have found it efficacious in fluxes, after a continued use for several weeks. Authors have cautioned us against the use of this bark where the intestines are ulcerated and disposed to cancer after fluxes.

IN diarrhœas, from absorption of pus, the simaruba has given relief; the former discharge from such ulcers was restored, and the pus meliorated.

LIENTERIA itself, and even hepatic fluxes, have been cured by the simaruba, after other medicines were tried without success. *Vide Act. Natur. curios. tom. ii. p. 80,—82.*

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IN putrid fevers, (as we are told) attended with coldness of the extremities, colliquative sweats and stools, and great dejection of spirits, this bark performed wonders, and many recovered by its use. *Vide* ROUPE de Morbis Navigantium, p. 311.

HABITUAL colics, with bloody stools, attended with fever and delirium, have been radically cured by the simaruba bark.

IMMODERATE fluxes of the menses and from piles, have been happily stopped by this medicine; and it would appear from some late trials, that fluor albus has been remedied by the same bark.

DE HAEN found the simaruba to be an excellent vermifuge; and used it with success in diseases depending on worms, particularly flukes.

My own experience, and that of many living friends, are convincing proofs to me of the efficacy of this medicine; and I hope the simaruba bark will soon be in more general use.

QUASSIA

QUASSIA SIMARUBA.

FLOS MASCULUS.

Cal. Perianthium monophyllum, parvum, quinquefidum, denticulis ovatis, erectis.

Cor. Petala quinque, sessilia, æqualia, lanceolata, subrevoluta, calyce triplo longiora, calyci inserta. *Nectarium* ex squamis decem, ovatis, villosis, basi filamentorum interiori insertis.

Stam. Filamenta decem, filiformia, æqualia, longitudine corollæ.

Antheræ oblongæ, incumbentes ; in centro floris corpus carnosum, orbiculatum, decem-fulcatum.

Pisillum nullum.

FLOS FEMINEUS.

Calyx et Corolla, ut in flore masculo.

Pisillum. Germina quinque subrotunda, introrsum coalita.

Stylus cylindraceus, erectus, quinque-partitus, longitudine corollæ. *Stigmata* subulata, recurvata, persistencia.

Pericarpium. Drupæ quinque laterales, distantes, receptaculo orbiculato, caroso insertæ.

Semina. Nux oblongo-ovata, acuminata, unilocularis. *Nucleus* compressus.

INFLORESCENTIA.

Panicula composita. Pedicellis subjicitur stipula lanceolata, petiolata. Folia alternato-pinnata. Foliola oblonga, obtusa, nitida, integra, basi attenuata, subsessilia ; costis lateralibus nervosis.

Quercus humilis mas



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Quercus humilis?

12
Quercus humilis?

13
Quercus humilis?

14
Quercus humilis?

15
Quercus humilis?

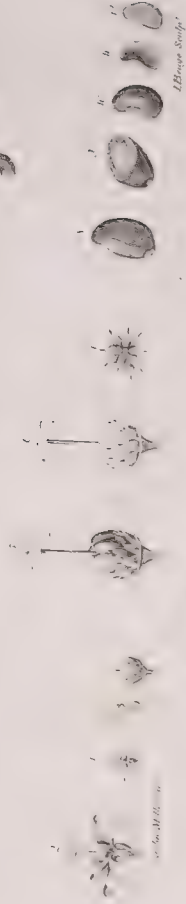
16
Quercus humilis?

Quercus humilis det.



IBengo. Sculp.

Indigofera tinctoria



Indigofera tinctoria

Indigofera tinctoria

EXPLANATION OF THE PLATES.

PLATE I.

QUASSIA SIMARUBA MAS.

1. A flower of its natural size.
2. The same magnified.
3. The calix of the natural size.
4. The same magnified.
5. The corolla.
6. The ten stamina.
7. Two stamina, the inside of one, the outside of another, presented to view.
8. The fleshy mass in the centre of the flower.
9. The same magnified, to shew in what manner the ten stamina and squamæ are placed.

PLATE II.

QUASSIA SIMARUBA FEMINEA.

1. 2. 3. 4. The same as in the male flowers.
5. The pistillum.
6. The style.
7. The ten imbricated squamæ.
8. One pericarpium or drupa.
9. The horizontal section of the same.
10. The nut.
11. A perpendicular section of the same.
12. The nucleus or kernel.

XI. *On the MOTION of LIGHT, as affected by refracting and reflecting Substances, which are also in Motion.* By JOHN ROBISON, M. A. F. R. S. EDIN. and Professor of Natural Philosophy in the University of Edinburgh.

[Read by Mr PLARFAIR, April 7. 1788.]

FEW of the mathematicians and philosophers of the present age have acquired a greater or better founded reputation than the celebrated Abbé BOSCOVICH; and there is none from whose writings I have received such variety of instruction and entertainment. His Theory of Natural Philosophy will ever be considered by impartial judges, not only as one of the boldest, but also as one of the most ingenious researches into the secrets of nature. There is hardly a branch of physico-mathematical philosophy which he has not cultivated with success; and in this cultivation he has exhibited the most acute penetration and the greatest address. In all his investigations too he has given the most beautiful specimens of geometrical invention and elegance, and greatly heightens the pleasure of his readers, by marking out distinctly the progress of his own mind in his researches.

Mr BOSCOVICH has lately obliged the public with a collection of several of his smaller works in five volumes quarto, published at Bassano in 1785. In the second and fourth volumes of this collection, are two very curious papers, on what is called the aberration of light, or the effect which is produced on the apparent place of visible objects by the motion of the observer.

There is one deduction which he makes from his premises, extremely curious in itself, and having the most surprising consequences. It is this: If a telescope be constructed, having its tube filled with water, and be directed to a terrestrial object properly situated, it will be found to deviate from that object by a certain determined quantity every day. It will follow from this, that a person shut up in a mine or dungeon, may, without seeing the sun or heavens, discover the motion of the earth round the centre of the solar system, and also whether this centre be in motion, and the velocity and direction of this motion.

THE contrivance of a telescope filled with water, has been long familiar to my thoughts, (as a means of discovering whether light be accelerated when refracted towards the perpendicular) in consequence of the speculations of my ingenious friend Professor WILSON of Glasgow. But all my attempts to construct such a telescope have hitherto proved abortive, for want of a substance sufficiently transparent to admit of the necessary magnifying power. I saw that this rendered useless the beautiful theory of their construction which is contained in this paper of Mr BOSCOVICH. But, at the same time, I saw that this aberration of terrestrial objects would enable us to decide the same question by means of a compound microscope of a very easy construction. If a cylindrical piece of glass be ground spherical at one end, and plane at the other, and if the plane surface be situated a small distance beyond the principal focus of the spherical surface, and a scratch be made on the plane surface, and considered as a visible object, an image of this scratch will be formed in the conjugate focus of the spherical surface, which image may be viewed by means of a deep eye-glass, as in the ordinary compound microscope. If this image be formed on a frame of wires, like the wires of an astronomical telescope, there must be observed the same diurnal deviation that Mr BOSCOVICH announces with respect to his telescope,

scope, but in the opposite direction; as in the microscope, there would be no want of light, we should have the most satisfactory decision of this important question in optics, and also the opportunity of detecting any hitherto unknown motions of the globe which we inhabit. It may also be shown, that, if any of these motions be very considerable, we shall determine another very important question in optics, *viz.* Whether the motion of light be affected by the motion of the luminous body.

ON these, and many other accounts, I was eager to construct this microscope, and set about it accordingly. But I happened at that time to be engaged in that part of my course of lectures where I had occasion to consider the apparent motions of bodies. I consider it as the fundamental proposition on this subject, that “*the apparent motion of a body is compounded of its real motion, and the opposite to the real motion of the observer.*” The consequence is, that, since the motions of the terrestrial object and of the observer are always nearly equal, there should be no apparent motion in the object, and therefore no apparent diurnal change of place. This startled me, and caused me to consider the matter more minutely. Professor WILSON, to whom I communicated my doubts, raised other objections, founded on the application of mechanical principles to that hypothesis, with respect to light, which the Abbé BOSCOVICH professes to maintain. In my subsequent speculations on this subject, I found, that the application of the above mentioned proposition was not strictly just with respect to the apparent *place* of the terrestrial object; but I was led by it to discover the real state of the matter, by applying it to the determination of the apparent motion of the *light* by which the object is seen. I thus detected the circumstance which Mr BOSCOVICH had overlooked, and which unfortunately puts an end to the hopes which I had entertained of many curious and important discoveries. I flatter myself that this Society will not think this subject unworthy of their notice; but am extremely sorry that my infirm state of health

health does not at present permit me to give such an account of it as its importance deserves. I propose, however, to undertake it as soon as I am able. This I am incited to do, not merely on account of the singularity of this particular subject, but more especially because its discussion depends on a more general, and hitherto unconsidered subject in physico-mathematical science, *the motion of light as affected by bodies which are also in motion*. This I have considered some years ago, as far as I thought necessary for my elementary course of lectures, and I then investigated the fundamental proposition which I shall include in this discourse. Perhaps I should offer some apology for troubling the Society with my thoughts on the subject before I have put them into a more perfect form. I shall frankly tell my reasons for this conduct. This paper of Mr BOSCOVICH must excite the attention of philosophers. Other speculations also which have lately been made by ingenious men, will turn the attention to the subject, and enquiries will be instituted, and their results made public. I should not chuse to be thought indebted to the researches of others for the results of my own enquiries, and therefore wish to ascertain my claim to any thing which may be valuable in my speculations, by this present imperfect account of them.

I SHALL therefore lay before the Society a short account of the experiment, as proposed and described by Mr BOSCOVICH, and of the result which he expects from it, and some of the most remarkable consequences which he deduces from this result. I shall, in the next place, point out the oversight which he has made in announcing the result, and state what ought to be the result, on the physical principles adopted by him; principles which will be overturned if the result of the experiment should be what he expects, but established if it should be what I assert. In the last place, I shall give the fundamental proposition for determining the reflection and refraction of light
by

by moving surfaces, and briefly mention some of the most useful corollaries.

LET O , (fig. 1.) be a terrestrial object, whose position is to be determined by an observer placed at B' , and furnished with a common surveyor's theodolite. He must place the index of his instrument so that the light coming from the object in the direction OB' , may pass through the two holes A' , B' , which constitute the plane sights of his theodolite; that is, the three points O , A' , B' , must be in a straight line. The instrument is so constructed that the straight line passing through the holes A' , B' , is parallel to a line NS drawn along the ruler or index upon which the sights are placed, and the division upon the arch, which is cut by the line NS , indicates the position of the object.

BUT now let us suppose that, by the motion of the earth, the observer is uniformly carried along the straight line $B'\beta$ perpendicular to $B'O$, while, in the mean time, the object is carried with an equal motion along the line $O\delta$ parallel to $B'\beta$. It is now evident, that, if the instrument, without altering its position, be carried along in the direction $B'\beta$, the light which enters the hole A' , in the direction OA' , will not pass through the hole B ; for, when the light entered the hole A' , the other hole was at B ; but when the light arrives at B' , the hole B' has got to some place R in the line $B'\beta$. Take the point B , so that the straight line $O\beta$ may be to $B'\beta$ as the velocity of light to the velocity of the earth. Through A' draw the straight line $A'A\alpha$, parallel to $B'\beta$, cutting the line $O\beta$ in the point A . Draw DAB parallel to $OA'B'$. Now, let the theodolite move from the situation $A'B'$ to the new situation AB , while the light moves from O to A . It is evident that the light will enter the hole A , and proceed in the direction $A\beta$. In the mean time, the hole B will have moved from B to β ; for $A\beta$ is to $B\beta$, as $O\beta$ is to $B\beta$, that is, as the velocity of light to the velocity of the theodolite.

dolite. Therefore an eye placed behind the hole B will receive the light which passes through it when in the situation β , and the observer will see the object through the sights of the instrument. He will see it by means of light moving in the direction $O\beta$; but he will not imagine that the object lies from him in the direction βO ; for he estimates the direction of the object by the position of the fiducial line of his instrument, which is always parallel to the line joining the centres of the holes which are its sights. When he sees the object, these holes are at β and α , and therefore the observer assigns to the object the direction $\beta\alpha$. Let BA and $\beta\alpha$ cut the line $O\delta$ in the points D and δ ; it is evident, that, when the object is at O, D and δ , the anterior sight of the theodolite, is at A', A, and α , and the other sight is at B', B and β ; therefore, when the object is seen through the instrument, it is always seen in its real place, and in its true direction, although not in the direction of the light by which it is seen; consequently, if the index be directed so that the object may be seen through it, that is, if the index be pointed to the object in the common way, and the whole instrument be kept firm in its position, it will *always* point to the object, although both the instrument and object are continually changing their places by the motion of the earth round the sun and round its own axis.

BUT now let us suppose, with Mr BOSCOVICH, that the interval between the two sights is filled with water contained in a tube, and bounded by two plates of glass at A and B, perpendicular to the line AB, and covered externally with paper, pierced with two small holes at A and B. Now, says Mr BOSCOVICH, the light which enters at A will not be at B when the hole B arrives there; for, if the velocity of light in water be to the velocity of light in air, as the sine of incidence in air to the sine of refraction in water, then, while the hole B comes to β , the light will move from A to E, so that AE is to A β as four to three nearly; consequently, when the light has come to

to β , the hole B will have moved over $B\gamma$, which is three-fourths of $B\beta$; therefore an eye, placed behind the hole B, will not see the object through the sights of the instrument, but will see an object lying to the right hand of it, having its angular distance equal to $\gamma A\beta$; or, if the instrument, instead of having a hole A for the anterior sight, has two fine wires crossing each other in A, the object will appear on the opposite side of their intersection from that towards which the earth is moving.

FROM this reasoning, Mr BOSCOVICH concludes, that if this instrument be placed at the earth's equator on the day of the winter's solstice, and the index be directed to the real place of an object due south of it, the object will not appear at the intersection of the cross wires of the anterior sight, but, at noon, will appear 5" to the east of that intersection, at six o'clock in the evening, it will appear 5" above it; at midnight, it will appear 5" to the westward of it; and at six o'clock next morning, it will appear 5" below it. The object will, therefore, appear to describe a circle round the intersection of the cross wires in twenty-four hours, the diameter of which will subtend an angle of 10". In other positions of the index, and other days of the year, the apparent motion of the object will be different; but it will never appear in its true place, except in those instants that the fiducial line of the instrument happens to be parallel to the line of the earth's motion at that time.

Mr BOSCOVICH proceeds to show that, if the theodolite has a common astronomical telescope, instead of plane sights, the appearances will be precisely similar. If the index be directed to the real place of an object, the object will be seen at the intersection of the cross wires of the eye-piece; and if the instrument be firmly fixed in its position, the object will always appear at this intersection, notwithstanding the motion of the earth. But if the telescope be filled with water, and be directed to the real place of an object situated as above mentioned, on the noon of the winter's solstice, the object will appear 5" to

the west of this intersection, and, in twenty-four hours, will describe round it a circle, whose diameter subtends an angle of $10''$, but in a direction opposite to that described round the intersection of the cross wires of the plane lights. The intelligent reader will easily see that these deductions are justly made from the premises.

Mr BOSCOVICH, in the last place, shows that if light be retarded in its passage from air into water, the appearances with the water telescope will be diametrically opposite to those above described, and therefore earnestly proposes this experiment to philosophers, as a mean of deciding that important question in physics. I call it an important question; because the acceleration of light in the inverse proportion of the sines of incidence and refraction affords an incontestible proof that the forces which refract light towards the perpendicular are directed perpendicularly *toward* the refracting surface, and nearly demonstrates that light consists of corpuscles emitted by the shining body. The retardation of light, in the direct proportion of the sines of incidence and refraction, is totally incompatible with this hypothesis concerning the nature of light; and, in my opinion, with the hypothesis of those who maintain that vision is produced by the undulations of an elastic fluid, although it has generally been supposed to be a consequence of that hypothesis.

I HAVE already said that my repeated attempts to construct a water-telescope of sufficient magnifying power have hitherto failed, in consequence of my not being able to find a fluid sufficiently transparent. Lime-water is the most transparent fluid that I know; and I have filled with it a telescope five feet long. But, when I increased its magnifying power to more than thirty times, it was vastly too dark, although the aperture was so great as to make it very indistinct. I am therefore convinced, that although I should employ Mr BOSCOVICH's most beautiful and ingenious construction to remove the indistinctness, there
would

would be a great deficiency of light; for a telescope of this length, magnifying thirty times, would not render 10" sufficiently distinguishable.

BUT this aberration of terrestrial objects, announced by Mr BOSCOVICH, must be observed in a compound microscope filled with water, or constructed in the manner described in the beginning of this discourse. In such a microscope, we can have abundance of light by external illumination, and little will be lost in its passage through the short column of lime-water or glass.

THE intelligent reader will easily see that this aberration of an object placed before the microscope must be observed even at the bottom of a mine. He will also see that, if the sun, with his attending planets, be carried along in any direction, with a velocity much greater than that of the earth in its orbit, another aberration will be observed, greater than the former, and distinguishable from it, although blended with it. Consequently, we should be able to discover, by means of this aberration, such hitherto unknown motion of the solar system. It will readily be believed, therefore, that I engaged with eagerness in preparations for this experiment, and in farther researches into its theory, and that I was greatly mortified when I found my hopes of curious discovery frustrated by the detection of an oversight in Mr BOSCOVICH's reasoning. This I shall now submit to the Society.

Mr BOSCOVICH supposes, that when the light, moving in the direction OA, enters the water tube at A, it moves on in the direction A β , describing AE uniformly, while the hole A moves from A to α . But Mr BOSCOVICH, in the same discourse, professes to maintain the opinion advanced by Sir ISAAC NEWTON, *viz.* That light is accelerated in water by forces which act perpendicularly to its surface. If this be the case, the light entering the water at A, in the oblique direction OA, will be refracted towards the perpendicular, and will move in the direc-

tion $A\varepsilon$, cutting the line $\alpha\beta$ in the point ε , so situated that $A\beta$ is to $A\varepsilon$ as the velocity of light in air is to its velocity in water. This line $A\varepsilon$ will cut the line $B\beta$ in some point i . Now, since the light moves uniformly along $A\varepsilon$, while the hole B moves uniformly along $B\beta$, it follows that they will meet in i , where the light will pass through the hole, and enter an eye placed behind it. The observer, therefore, will see the object through the water tube or water telescope, having the same position with the plane sights or common telescope; and if the water telescope be directed to the real place of a terrestrial object, however situated, and be firmly fixed in its position, the object will always be seen on the intersection of the cross wires, and no aberration will be observed in consequence of the earth's motion.

I MAY here observe, that this aberration of terrestrial objects occurred to Mr BOSCOVICH but very lately, namely, while he was writing for the press his Dissertation on the use of the water telescope, for deciding the question concerning the acceleration or retardation of light, by means of the aberration of the fixed stars. It appears that Mr BOSCOVICH has long had this ingenious thought; for M. DE LA LANDE, in the fourth volume of his Astronomy, mentions his having received a letter to that purpose from Mr BOSCOVICH in the year 1769. Mr BOSCOVICH, in the first volume of his Opuscula, published at Bassano in 1785, mentions his having heard that some person had published a dissertation in the Philosophical Transactions of London upon the same subject, and seems disposed to think, that the author had been indebted to Mr DE LA LANDE's information, which had been published some time before. This alludes to a Dissertation by our worthy member Mr WILSON, now professor of Astronomy at Glasgow. But this gentleman's ingenuity is too eminent to make him need any information which his candour would not dispose him to avow in the most public manner. In the present instance, he is fortunately protected.

ected against every imputation of plagiarism, as I shall presently make appear, by returning again to the consideration of the apparent place of objects viewed through a theodolite.

SUPPOSE that the object O is a fixed star, and that, while a ray of light proceeds from it in the direction $OA\beta$, with a uniform motion, the theodolite moves uniformly from the situation $A'B'$ to the situation $\alpha\beta$. It is evident, that the light will enter the anterior sight at A , and pass through the posterior sight at β . An observer, therefore, will see the star by looking through the theodolite. But he will judge falsely of its place; for he will imagine that it lies in the direction $\beta\delta$, while it is really in the direction βO . The angle $O\beta\delta$ is called the aberration of the star, and the proportion of the velocity of light to the velocity of the earth is such that this angle is about $20''$. Let us now suppose that the water tube is used. Then, says Mr BOSCOVICH, if the water tube have the same position with the plane sights, the star will not be observed through it; because, when the hole B has come to β , the light which entered at A has got to E , and when this light has got to β , the hole has got only to γ : Therefore, in order to see the star, the water tube must have a different position, which he thus determines:—Make $B\phi$ equal to $\beta\gamma$, and draw $A\phi$. This will be the proper position of the tube. For, while the light which enters at A moves from A to β , the posterior sight of the theodolite will have moved from ϕ to β , where it will meet the light, and allow it to pass through to the eye of the observer. If the velocities of light in air and water are as three to four, the angle $BA\phi$ will be about $5''$, in the opinion of Mr BOSCOVICH, and the aberration of the star will be about $15''$, namely, three-fourths of the aberration discovered by the plane sights. In like manner, when the aberration of the star is observed with a telescope filled with water, by bringing its image to the intersection of the cross wires in the eye-piece of the telescope, it will be

be three-fourths of the aberration observed in the same manner with the common telescope. This account of the experiment is precisely the same with that given by Mr DE LA LANDE, and also with that given by Mr BOSCOVICH in the Dissertation above mentioned.

IT is easy to see, that Mr BOSCOVICH has made the same oversight here as in the case of terrestrial aberration. For, in the *first* place, if the tube has the position AB, the light which enters at A, in the direction OA, will not proceed in the direction AE, but be refracted at A, and proceed in the direction A*ε*, and will meet with the hole B in the point i. The star will, therefore, be seen through the water tube, having the same position with the plane sights; and if the aberration be observed with a common telescope, and a telescope filled with water, by bringing the image of the star to the intersection of the cross wires, it will be the same in both. In the next place, if the water tube have the position A*φ*, which Mr BOSCOVICH proposes, the light which enters at A will not pass through the posterior sight. For the angle BA*β* being 20", and the angle BA*φ* being 5", the angle of incidence will be 15", and the light will still be refracted towards the perpendicular, making with it an angle somewhat greater than 11".

THUS it appears, that the result of this experiment, made in the manner proposed by Mr BOSCOVICH, will be different from what he announces upon the physical principles assumed by him. What I have here determined to be the result of this experiment, perfectly agrees with Mr WILSON's determination in the Philosophical Transactions, where it is proposed by him as a proof that light is accelerated by refraction out of air into water, in the inverse proportion of the sines of incidence and refraction. Thus, these gentlemen differ so widely in their opinions, both with respect to the result of the experiment, and the conclusions drawn from it, that the one cannot be suspected of having borrowed from the other.

I SHALL just add here, that if the aberration of the fixed stars, observed in Dr BRADLEY's manner, as above described, be different with the two telescopes, as Mr BOSCOVICH expects, or if there be observed that aberration of terrestrial objects which he describes, *light is not accelerated*, while refracted towards the perpendicular, in the inverse proportion of the sines of incidence and refraction. But if the two aberrations shall be found to be the same, and if no terrestrial aberration shall be observed, we have a direct proof of the acceleration of light in the above mentioned proportion, and of its refraction being produced by forces acting perpendicularly to the refracting surface, and almost a demonstration that light consists of corpuscles emitted by the shining body. There is indeed another way of observing the aberration of the fixed stars, *viz.* by a micrometer within the eye-piece of the telescope. This promises a different aberration with the two telescopes. But my thoughts on this subject are not yet ready for the examination of the Society.

I NOW proceed, in the last place, to give the fundamental propositions respecting the motion of light, as it is affected by refracting or reflecting substances, which are also in motion; propositions which will afford an easy and ready solution of every question which may be proposed.

THERE are two ways of establishing the fundamental doctrines on this subject. The first and best method is to state the leading facts, or to announce the general physical laws as matters of observation and experience, and then to give a theory of all the subordinate phenomena, in the order of their generality, by showing in what manner they are comprehended under the general laws already established. But, in the present case, this method cannot be followed. For, in the phenomena which we observe, the motion of light is blended with several motions which we *know* to obtain in the reflecting and refracting substances which affect it, and perhaps with many other motions

motions of which we are entirely ignorant. For this reason, we cannot say *what is the absolute motion of light*, nor ascertain *from fact* what *changes* it undergoes in its observed refractions and reflections. Since, therefore, we cannot simplify the phenomena which nature presents to our view, we cannot establish those general laws which would be the foundation of a physical theory.

THE only other method which seems to remain, is to take up such opinions concerning the nature of light, as seem most rationally deducible from the phenomena which we observe, and then to deduce, by the established principles of mechanics, such consequences as should arise from the action of refracting and reflecting substances upon this hypothetical light. We should then select such of these consequences as will admit of a comparison with observation. If these consequences shall be found inconsistent with observation, the hypothesis concerning the nature of light must be rejected, and trial must be made of a new one. But if they should be found to agree with observation, and at the same time be sufficiently various, we may then admit the hypothesis to have a degree of probability proportioned to the extent of the comparison which we have made of its consequences with observation; we may then discover by this means parts of a hypothesis which must be admitted as true, although the hypothesis cannot be demonstrated in its full extent.

I AM acquainted with two hypothesis only concerning the mechanical nature of light, which, in the opinions of the learned, seem rationally deduced from the phenomena. The first is that which is advanced by Sir ISAAC NEWTON, in several parts of his celebrated writings. He says that light may perhaps consist of small particles emitted by the shining body with prodigious velocity, which are afterwards acted upon by other bodies, with attracting or repelling forces like gravity, which deflect them from their rectilineal courses in refractions and

and reflections. He shows, if this be the case, that the combined forces of all the particles of a body which act at once on a particle of light, compose a force whose direction is perpendicular to the surface of the body. When, therefore, these forces tend *toward* the body, the light, at its approach to that body, is *accelerated* and is refracted *toward* the perpendicular to its surface. But when these forces tend *from* the body, the light is *retarded*, refracted *from* the perpendicular, and sometimes *reflected* with its former velocity, and in an angle equal to the angle of incidence. When these consequences are compared with observation, the most complete agreement is found to obtain. Hence Sir ISAAC NEWTON deduces, that when light is *observed* to be refracted toward the perpendicular, it has really been actuated by forces tending toward the refracting body, and that it is accelerated. But when the light is refracted from the perpendicular, it has been actuated by forces tending from the body, and is retarded. Also, when it is reflected on its approach to a body at an angle equal to the angle of incidence, it has been actuated by forces tending from the body, and moves with its former velocity. When these conclusions are combined with the former deductions from the hypothesis, and the result is compared with observation, the most perfect agreement is still discovered. For these reasons, this hypothesis has acquired great credit, and deserves to be examined on the present occasion.

THE other hypothesis is that of Mr HUYGHENS and Dr HOOKE. These gentlemen suppose that, as hearing is produced by means of the tremulous motion of elastic air, which affects the ear, so vision is produced by the tremulous motion of elastic light, which affects the eye. This hypothesis was announced and applied to the explanation of phænomena in very general terms, and did not, for a long while, much engage the attention of the learned. The celebrated mathematician Mr EULER has lately brought it into credit, having made some alterations

in it. He supposes, that vision is produced by the tremulous motion of an elastic fluid which he calls æther, and which he supposes to pervade all bodies. He attempts to show that the propagation of this tremulous motion is analogous to the appearances in the reflection and refraction of light. I confess that I cannot admit his reasonings on this subject to be agreeable to the principles of mechanics; and I am decidedly of opinion, that the propagation of the tremulous motion of an elastic fluid is totally inconsistent with those facts in vision where no refraction or reflection is observed. But I shall reserve my objections till another opportunity, when I propose to submit to this Society a mechanical examination of this hypothesis, and I shall admit for the present that Mr EULER's explanation of refraction and reflection is just. It is an essential proposition in this hypothetical theory, that the velocities of the incident and refracted light are proportional to the sines of incidence and refraction, and therefore that light is retarded when it is refracted toward the perpendicular. It seems a necessary consequence that, in this case, the particles of æther are actuated by forces tending from the refracting body. I shall, therefore, consider what effects must result from the combination of this retardation with the motion of the refracting body. If time will allow, I shall consider what will be the effects produced on the motion of light by the motion of the visible object. These are so different in the two hypotheses, that it is very probable that some natural appearance may be found which will give us an opportunity of determining whether either of these hypotheses is to be received as true. Dr ROBERT BLAIR, professor of Astronomy in this University, has pointed out a case of this kind, in the rotation of the planet Jupiter round its axis, and has suggested a method of investigation, exceedingly ingenious, and which seems to promise success. I think that another may be observed in the planet Mercury, when in his greatest elongations from the sun.

I NOW begin with an examination of the Newtonian hypothesis. But I shall content myself with one consequence of it only, *viz.* That in refractions and reflections, the light is actuated by forces whose direction is perpendicular to the surface of the refracting or reflecting body. I shall here consider the effect of such forces only as tend toward the body; because it will be evident that the same reasoning will apply, without any variation, to the effects of forces tending from the medium.

LET XZY (fig. 2.) be a plane surface which separates a refracting medium, such as glass, from a void, the medium being supposed to be below the plane XY. Let it be supposed that ZA, perpendicular to ZY, is the greatest distance at which a particle of the medium acts upon light. Make ZB, on the other side of XY, equal ZA, and draw the planes AQ, BS, parallel to XY. While the light is between the planes AQ and BS, it is affected by the refracting forces. For while it is between the planes AQ and XY, it is acted on by all the particles of the medium, whose distance from it does not exceed ZA; and while it is between the planes XY and DS, there are more particles below it whose distance does not exceed ZA than there are above it. But when the light is below BS, it is equally acted on in all directions, and its motion through the medium is not affected by the refracting forces.

LET us call the space contained between the planes AQ and BS by the name of the refracting stratum; and let us suppose, at first, that the refracting forces act uniformly through the whole extent of the stratum.

LET the light, moving in the direction HAF, enter the refracting stratum at A, while the medium is moving in the direction AI; and let AF, AI, be the spaces which they would uniformly describe during the time that the refracting forces would impel a particle of light, from a state of rest in A, through AB. Let the velocity which the light would acquire by this acceleration across the refracting stratum, be called the

specific velocity of the medium. It is known that, if it moved uniformly with this velocity, it would describe AO, double of AB, during the time of describing AB with the uniformly accelerated motion. Therefore, (taking this for the unit of time) AF, AI and AO, will express the velocity of the incident light, the progressive velocity of the medium, and the specific velocity. It is also known, that the light, in passing through the refracting stratum, will describe a parabola ACL, which AF touches in A, and of which AB is a diameter, having BL, equal and parallel to AF, for an ordinate.

PRODUCE IA till Ai is equal to AI; complete the parallelogram Affi, and draw the diagonal Af. The motion Af, compounded of AF, the real motion of the incident light, and Ai, the opposite to the motion of the medium, is the relative motion of the incident light. This motion will be uniform, because it is compounded of motions which are uniform. Therefore Af will express the relative velocity of the incident light. Draw FL. It is evidently equal and parallel to AB. Let CP be drawn from any point C of the parabola, parallel to AB, cutting AF in P. Complete the parallelograms FLlf, fIBA. Draw Cc parallel to Ff, and make $Ff : Cc = AF : AP$. I say that the point c is in a parabola Acl, of which AB is a diameter, and Af a tangent, and which is the relative path of the light, and that L and l, C and c, are contemporaneous places of the light in its real and relative paths. Draw Pp parallel to Ff, cutting Af in p. Draw the ordinate CK, and draw pc, Kc. Then $Ff : Pp = AF : AP, = Ll : Cc$. But Ff is equal to Ll. Therefore Pp is equal to Cc, and pc is equal and parallel to PC and AK, and Kc is equal and parallel to Ap. Therefore $Kc^2 : Bl^2 = Ap^2 : Af^2, = AP^2 : AF^2, = KC^2 : BL^2, = AK : AB$. Therefore the points A, c, l, are in a parabola, of which AB is a diameter, Af a tangent, and Kc, Bl, are ordinates. Also, because $Ll : Cc, = Ff : Cc, = AF : AP, = T, AF : T, AP$, (by the symbol T, AF, &c. is expressed the time of moving along AF,

AF, &c.) it is evident that Cc is equal and opposite to the motion of the point A, while the light describes the parabolic arch AC, and that Ll is equal and opposite to the motion of A, while the light describes the arch ACL. Therefore L and l, C and c, are contemporaneous places of the real and relative paths of the light, and the parabola Acl is its relative path.

WE have seen that Af is the relative motion of the incident light during the time of describing AB by the impulse of the refracting forces acting on a particle of light at rest in A. Let us now suppose that the medium is at rest, and that the light enters the refracting stratum at A, with the velocity and in the direction Af. It must describe a parabola, which Af touches in A, and of which AB is a diameter and Bl an ordinate; that is, it must describe the very parabola Acl, and it must describe it in the same time that the light incident with the velocity, and in the direction AF, describes the parabola ACL. Its motion, therefore, both before and after refraction, is the same with the relative motion of the light having the velocity and direction AF, incident on the medium moving with the velocity and in the direction AI.

LET c be the point of intersection of the parabola Acl and the plane BS. Draw cC parallel to Ai, cutting the parabola ACL in C. C must be the point of that parabola, where the refraction by the moving medium is completed. For Ll : Cc = Af : Ap, = AF : AP, = T, AL : T, AC, = T, Al : T, cC. Therefore, while the light moves from A to c, the point c moves from c to C, where the light will pass through it, and the refraction be completed, the plane BS having now gotten into the situation bs, and the plane AQ into the situation aq.

DRAW the ordinates ADE, Ade, to the diameters PC, pc; and draw mr, the directrix of the parabola Acl, and join Dd. It is known that AF is to AE as the velocity in A to the velocity in C. Now, AE : AD = AF : AP, = Af : Ap, = Ae : Ad. Therefore, Dd is parallel to Cc. Therefore the velocity Ae, compounded:

compounded of AE and Ee, which is equal and opposite to AI, is the relative velocity of the light in C, and Af, Ae, are the relative velocities of the incident and refracted light. Now, $Kc^2 = AK \times 4Am$ and $Ad^2 = cd \times 4cr = AK \times 4cr$. Therefore, $Ad^2 - Kc^2 = AK \times 4cr - 4Am = AK \times 4AB$. Now, $Ad^2 : Ae^2 = Ap^2 : Af^2 = Kc^2 : Bl^2 = AK : AB$. Therefore, $Ae^2 - Af^2 = AB \times 4AB = AO^2$. That is, when the light has passed through, and emerges from the refracting stratum, the difference between the squares of the initial and final relative velocities is equal to the square of the specific velocity of the medium.

ALSO, (because $Qe^2 - Qf^2 = Ae^2 - Af^2$) the difference between the squares of the initial and final relative perpendicular velocities, is equal to the square of the specific velocity.

BUT it will not always happen that the light will emerge from the refracting stratum after passing over it, and it may frequently happen that it will not pass over the whole extent of it.

THUS, suppose the light to be within the medium, moving towards the refracting stratum, while the medium is moving more slowly towards the same quarter, or moving towards the opposite quarter; and let the relative perpendicular velocity of the light be equal to the specific velocity. Suppose that the light passes through the refracting stratum at A (fig. 3.) moving in the direction and with the velocity AF. It would describe (by the action of the refracting forces) the parabola ALC, of which AB', equal to AB, is the abscissa from a diameter, and BL, equal and parallel to AF, is an ordinate. Draw Ln parallel to AQ, cutting FL in n. It is plain that dn is the perpendicular velocity of the medium, dF the perpendicular velocity of the incident light, and nF its relative perpendicular velocity. This is equal to twice AB by supposition. But FL is equal to AB; therefore Ln is also equal to AB, and An is an ordinate to FL. Also, LB, drawn from L to B, is a tangent at L, and BLs is the situation of the plane BS, when the light
which

which entered the refracting stratum at A is at L. BL is the velocity with which the light passes through L, and Bb is its perpendicular velocity. This is evidently equal to dn, the perpendicular velocity of the medium. Since, therefore, they have the same velocity in the direction LF, it is plain, that the light will not pass through the plane bL; and because it is subjected to the action of the refracting forces, it will be deflected towards AQ, and will describe another arch LC of the parabola, and will be met in C by the point c of the plane AQ, which has moved in the mean time through cC parallel to lL. The point l is the vertex of the relative path Alc, and the abscissa lg being equal to BA, it is evident that fg, the relative perpendicular velocity, is equal to twice BA, that is, to the specific velocity.

If, as in fig. 4. the relative perpendicular velocity of the light be less than the specific velocity, it will not pass through the whole refracting stratum: For draw ln parallel to AQ, cutting FL in n. It is plain that dn is the perpendicular velocity of the medium, and dF the perpendicular velocity of the light, and nF the relative perpendicular velocity. Because this is supposed less than twice AB, Ln is less than FL, and An is not an ordinate to FL. Let oVh, parallel to An, touch the parabola in V, and draw hk perpendicular to AB. Then oK, or nd, is the perpendicular velocity of the light. Therefore, since the perpendicular velocities of the light in V, and of the medium, are equal, the light is then the nearest possible to the plane BS, which has now obtained the situation bs. It is therefore in the vertex of the relative parabola, or, drawing Vv parallel to Ff, v will be the vertex of the relative path Avl; therefore the light, after passing through V and L, will describe another arch LC of its parabolic path, and it will be met in C by the point c of the plane AQ, which has in the mean time moved along cC. Fig. 5. exhibits the same particulars in the case when the light within the medium is moving *from* the refracting stratum, but is overtaken by it.

THUS

THUS we see that when the light within the refracting medium either meets or overtakes the refracting stratum, or is overtaken by it, and the relative perpendicular velocity is not greater than the specific velocity, the light does not emerge from the medium, but is reflected back into it.

IT is farther to be observed, that in these cases, the angle of relative reflection is equal to the angle of relative incidence, and the *relative* velocity of the light after reflection is the same as before reflection. For the tangents At, tc, (fig. 3. 4. 5.) are equally inclined to the axis of the parabola Alc, and equal portions of them will be intercepted by the diameters AB, FL, and these portions express the relative velocities of the light in A and c. Also, the relative perpendicular velocity of the reflected light is equal to the relative perpendicular velocity of the incident light, but in the opposite direction.

LET us suppose, that the refracting stratum is divided into several partial strata, by planes parallel to AQ and BS, and that the forces are different in each stratum, but uniform through its whole extent.

THE relative motion of the light, emerging from the posterior surface of the first partial stratum, is the relative motion of the light immersing into the second stratum. Therefore, by the preceding reasoning, the relative motion of the light emerging from the posterior surface of the second stratum, is the same as if the medium had been at rest, and the light had approached it with the same relative initial motion. The same must be affirmed of all the partial strata in succession, and is therefore true with respect to the final motion of the refracted light.

FURTHER, the whole change which is made on the square of the relative velocity of the incident light, in those cases where it passes through and emerges from the refracting stratum, is equal to the square of the velocity which a particle of light would acquire if impelled by the variable refracting forces from a state of rest through the whole refracting stratum.

For

For if the medium were at rest, and the light approached it with the same relative motion, we have seen that the *absolute* velocity with which the light enters any one of the partial strata, is the same with the relative velocity with which it enters it when the medium is in motion. Now, when the medium is at rest, the change made in the square of the absolute velocity (whatever this velocity be) is equal to the square of the specific velocity of that stratum. Therefore, if the velocity with which the light enters this stratum be that which it would have acquired if impelled by the refracting forces from a state of rest at A, in the anterior surface of the first stratum, the change made on the square of this velocity would have been still the same, and the whole velocity would be that acquired by the varied impulse from a state of rest in A. This is true with respect to the last stratum; and therefore if the light enter the refracting stratum of the quiescent medium with any velocity, and in any direction whatever, the change made in the square of its velocity, when it has passed through all the partial strata, and emerged from the last of them, is equal to the sum of the squares of their respective specific velocities, and this sum is equal to the square of what may be called the specific velocity of the whole refracting stratum. Now, the absolute velocity with which the light emerges from the refracting stratum of the quiescent medium is the same with the relative velocity with which it emerges from the refracting stratum of the medium in motion. Therefore, the change made on the square of the relative velocity of the incident light is equal to the square of the specific velocity of the medium.

WE need not employ any time to show that this is also true with respect to the relative perpendicular velocity. Nor will it be necessary to show that when the light, moving within the medium, meets with or overtakes the refracting stratum, or is overtaken by it, and the relative perpendicular velocity of the

incident light is not greater than the specific velocity of the medium, it will not emerge from the refracting stratum, but will be reflected back again in the medium; nor to show that the angle of reflection is equal to the angle of incidence, and that the relative velocity of the reflected light is equal to that of the incident light, and that the relative perpendicular velocity of the reflected light is equal to that of the incident light, but in the opposite direction.

Lastly, LET the number of the partial strata be augmented, and their thickness diminished, without end. The foregoing demonstration will now be applicable to the motion of light through refracting substances which are in motion, and which act on it with forces, *continually* varying according to any law of the distances; and it may be received as the fundamental proposition on this subject, that,

If a ray of light, moving in any direction and with any velocity, meet with the surface of a refracting medium, which is in motion, its final relative motion will be the same as if the medium had been at rest, and the light had approached it with the same initial relative motion.

IT is easy to see that what has been said about the motion of light within a medium which acts upon it with attractive forces, will apply to the motion of light which is without a medium that acts upon it with repelling forces. In such a case, the light will not be refracted into the medium, unless its perpendicular relative velocity be greater than the specific velocity of the medium, but will be reflected with an equal relative velocity, and at an equal relative angle on the other side of the perpendicular.

IT is also easy to see that the foregoing demonstration will apply to the motion of light through two contiguous mediums. For there will be a refracting stratum, where the light will be affected by the sum or the difference of the
refracting

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refracting forces, according as they act in the same or opposite directions *.

I

* IT was about the beginning of 1784 that I investigated the foregoing demonstration, which, as the reader will see, is conducted after the method adopted by Sir ISAAC NEWTON, in his demonstration of the 94th proposition of the first book of the Principia. I applied to my much esteemed colleague Mr Professor PLAYFAIR, for his assistance in a case to which the foregoing demonstration may perhaps be thought not to extend, namely, when the motion of the light, and that of the medium, are perpendicular to the refracting surface. Before I had obtained a demonstration which pleased me, he favoured me with the following elegant analytical demonstration.

LET v be the velocity of a particle of light when it has arrived at the distance x within the refracting medium (x being counted from the point in which the particle began to be acted on, and being less than the distance from that point at which the motion of the particle again becomes uniform.) Let f be the force acting on the particle at the distance x . Let a be the velocity of the incident light, and c the velocity of the medium in the opposite direction.

It is evident that the force f does not act on the particle during its passage through the whole space $\dot{x}$, but only during its passage through the part $\frac{v}{v+c} \dot{x}$. Therefore,

$$v^2 = a^2 + 2 \int \frac{f v \dot{x}}{v+c}, \text{ and } 2v \dot{v} = \frac{2v f \dot{x}}{v+c}, \text{ or } 2\dot{v} = \frac{2f \dot{x}}{v+c}.$$

That is, $2v \dot{v} + 2c \dot{v} = 2f \dot{x}$, and, taking the fluent, $v^2 + 2cv = 2 \int f \dot{x} + C^2$. But when $2 \int f \dot{x} = 0$, we

have $v^2 + 2cv = a^2 + 2ac$, and therefore $v^2 + 2cv = a^2 + 2ac + 2 \int f \dot{x}$. Let

the fluent of $2 \int f \dot{x}$ (assumed, so that x shall be the distance at which the velocity of the light again becomes uniform) be supposed $= g^2$. Then $v^2 + 2cv = a^2 + 2ac + g^2$.

Add c^2 to both sides of the equation. Then $v^2 + 2vc + c^2 = a^2 + 2ac + c^2 + g^2$;

and therefore $\overline{v+c}^2 = \overline{a+c}^2 + g^2$. But $a+c$ is the relative velocity of the

incident light, and $v+c$ is the relative velocity of the refracted or accelerated light.

Therefore the square of the latter exceeds the square of the former by the constant quantity g^2 . Now, $g^2 = 2 \int f \dot{x}$; and is therefore (by the celebrated 39th proposition of the

first book of the Principia) the square of the velocity which a particle of light would acquire if impelled from a state of rest through the whole distance at which the medium acts on light.

I NOW proceed to deduce some of the most useful corollaries from the general proposition.

Corollary 1. THE relative velocities of the incident and refracted light are directly as the co-secants, or inversely as the sines of the relative angles of incidence and refraction. For it was demonstrated, that Af and Ae (fig. 2.) are in the proportion of the velocities of the light in the points A and c of its relative path. Now, if ef cuts the plane AQ in the point Q, and AQ be considered as the radius, Af and Ae are the co-secants of the angles B Af and BAe, which are the relative angles of incidence and refraction. Also, Af is to Ae as the sine of the angle AeQ to the sine of the angle AfQ, that is, as the sine of the angle BAe to the sine of the angle B Af, that is, as the sine of the relative angle of refraction to the sine of the relative angle of incidence.

Cor. 2. IF the relative velocity of the incident light be the same in all the relative angles of incidence, the relative velocities of the refracted light will also be equal in all the relative angles of refraction. For the sum or the difference of the square of the relative velocity of the incident light, (which is a constant quantity) and the square of the constant specific velocity, constitute a surface which is also constant, and which is equal to the

SINCE the relative velocities, estimated in a direction parallel to the refracting surface, are not changed by the action of the refracting forces, it evidently follows from this demonstration that the difference between the squares of the relative velocities of the incident and refracted light, is equal to the square of the specific velocity of the medium, whatever may be the directions of the incident and refracted light, and therefore, that the final relative motion of the refracted light is the same as if the medium had been at rest, and the light had approached it with the same relative motion. But although this demonstration would have been much more elegant, and more agreeable to the manner in which I have been accustomed to explain the refraction of light, I chose to retain the demonstration which I have given in the text, because I think that it gives me a better opportunity of exhibiting to the mind the whole motion of the light during its refraction or reflection. At the same time, I thought it my duty to communicate, with Mr PLAYFAIR's permission, his demonstration to the public.

the square of the relative velocity of the refracted light. This is therefore a constant quantity, or the relative velocity of the refracted light is the same in all the relative angles of refraction.

Cor. 3. IF the relative velocities of the incident light be the same in all angles of incidence, the sines of relative incidence and refraction are in a constant ratio, namely, the inverse ratio of the relative velocities of the incident and refracted light. This appears by combining the last corollary with the first.

Cor. 4. WHEN light moving with the same velocity in all directions, is refracted by a medium at rest, the sines of incidence and refraction are in the constant ratio of the velocities of the refracted and incident light. This appears from the last corollary.

Cor. 5. IF the light moving in a medium A be refracted by a medium B, which is in motion, and emerge from it into the medium A, it will regain the relative velocity which it formerly had when in this medium. For the square of its relative velocity while in the medium B, differs from the square of each of its relative velocities in the medium A by the same quantity, *viz.* by the square of the specific velocity of the medium B. It is evident that the same thing will happen when the light passes through several contiguous mediums in motion before it emerges again into the medium A.

Cor. 6. IF the relative paths of the light before its entering into the medium B, and after its emergence from it, be equally inclined to the direction of the medium, the absolute velocities of the incident and emergent light will be equal, but in no other case. This is easily seen by resolving the relative motions of the incident and emergent light. Hence we learn, that if the plane surface of a plano-convex lense be turned towards a fixed star to which the earth is approaching, or from which it is receding, the absolute velocity of the lateral emergent rays will be increased or diminished.

Cor.

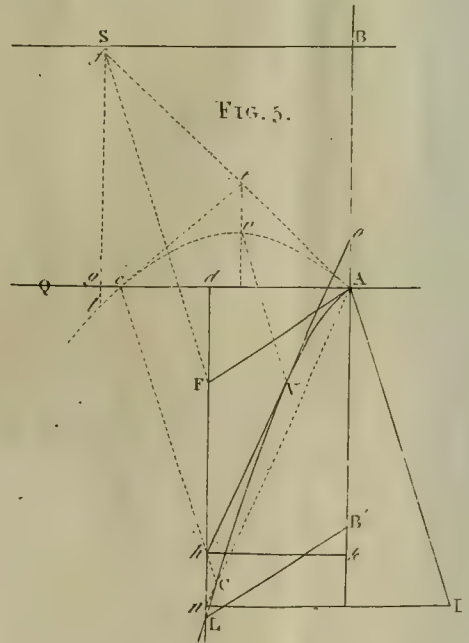
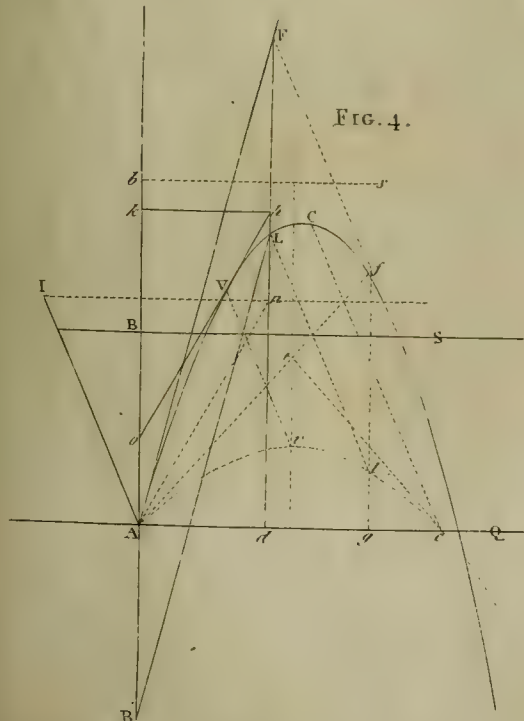
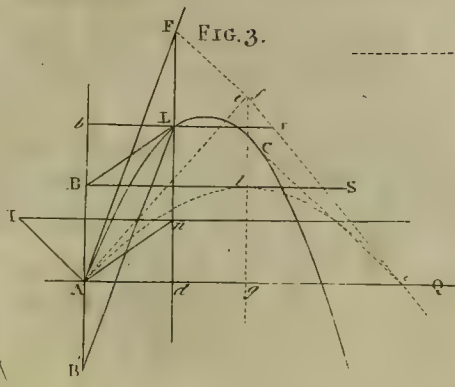
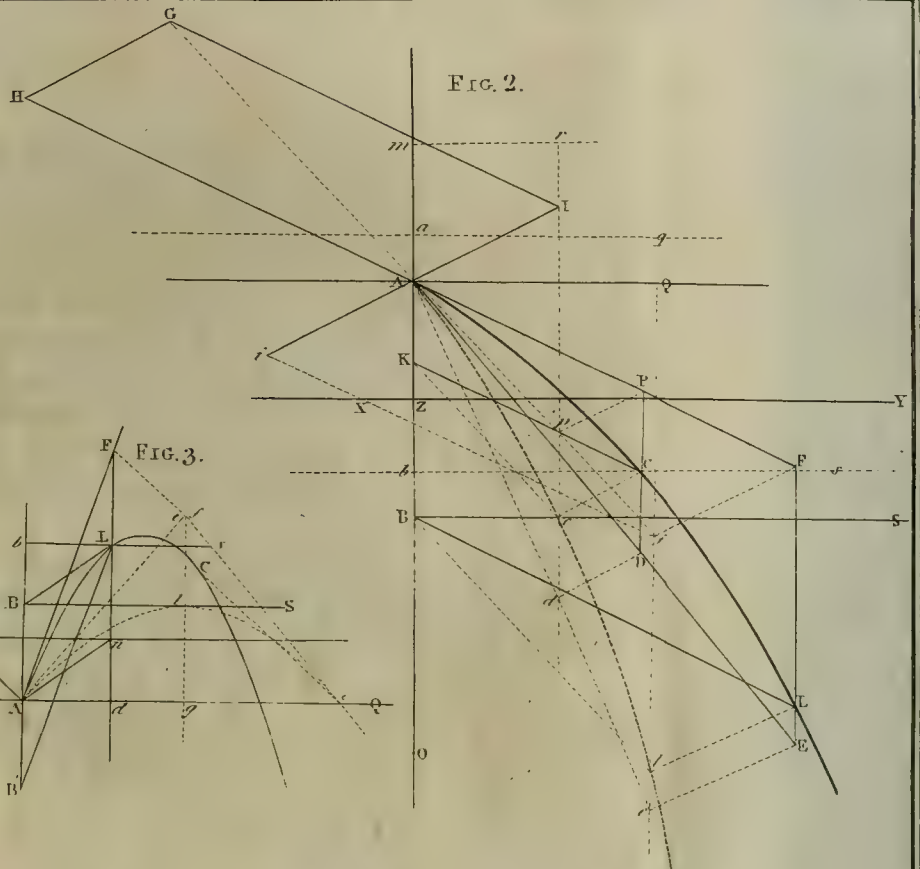
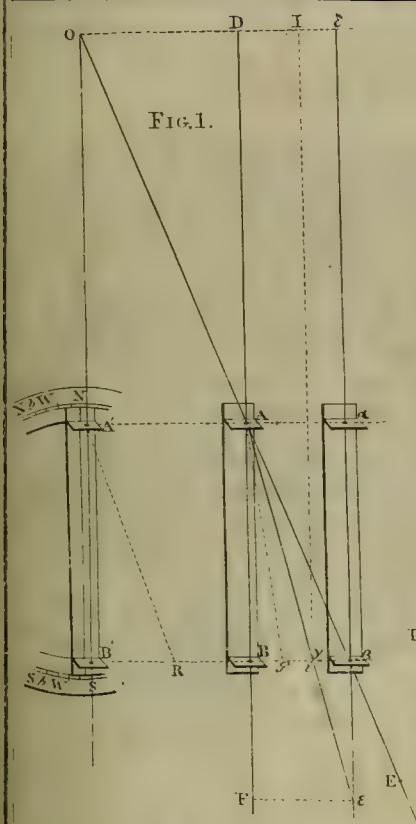
Cor. 7. WHEN the light is reflected, the relative angles of incidence and reflection are equal, as also the relative velocities of the incident and reflected light.

Cor. 8. BUT the absolute angles of incidence and reflection, and also the absolute velocities of the incident and reflected light, are unequal, except in the case where the motion of the reflecting substance is in the direction of the reflecting plane.

IF the plane be moving towards that side from which the light comes, the angle of reflection will be less than that of incidence, and the perpendicular velocity of the reflected light will exceed that of the incident light by twice the perpendicular velocity of the reflecting plane. The contrary will happen if the plane be moving towards the opposite side.

THE application of the foregoing proposition to Mr BOSCOVICH's experiment is extremely simple. When the telescope is so directed that the image of the object is formed upon the intersection of the cross wires in the eye-piece, the relative motion of the light is performed along the axis of the telescope; or the axis of the telescope is in the direction of the relative motion of the light, and indicates the apparent position of the object. Now, when the water telescope has the position AB, (fig. 1.) the relative motion of the light in the telescope is the same as if the telescope had been at rest, and the light had approached it with the same relative motion. Now, the motion DA is evidently the relative motion of the incident light. For it is composed of OA, the real motion of the light, and DO, the opposite to the real motion of the telescope. Now, if the telescope had been at rest, and the light had entered it in the direction and with the velocity DA, it would have proceeded in the direction AB, and therefore the telescope must always be directed to the real contemporaneous place of the terrestrial object, and there will be none of that diurnal deviation which Mr BOSCOVICH asserts.

THUS





THUS it appears that the water telescope must have the same position with the common telescope, or that both of them must always be directed to the real place of the terrestrial object.

IT will also easily appear, that when the image of a fixed star is formed upon the intersection of the cross wires in the eyepieces of a common telescope, and a telescope filled with water, the two telescopes will have the same position, and will indicate the same aberration of the fixed stars. For, by the same reasoning, it appears that the water telescope at A must have the position AB, and the aberration OAD is the same with that observed with a common telescope.

WITH this application of the general proposition I shall conclude this paper, reserving a farther account of the subject for another opportunity, if the Society shall think it worthy of their attention.

XII. DEMONSTRATIONS of *some of* Dr MATTHEW STEW-
ART's GENERAL THEOREMS. By ROBERT
SMALL, D. D. F. R. S. EDIN.

[*Read by the Author, Feb. 7. 1785.*]

THAT excellent Geometer the late Dr MATTHEW STEW-
ART, as long ago as the year 1746, published his book
of General Theorems, all of them, except the first five, without
the demonstrations. As I do not find that any demonstration
of them has ever been made public, I may perhaps flatter my-
self that what I now communicate to this Society will not be
wholly unacceptable. The demonstrations given are of the
propositions relating to the sums of the squares, and of the
fourth powers of lines drawn in a certain manner, and are
selected from the rest, as most connected with one another. The
theorems that respect the cubes and other higher powers, may
afford materials for another paper, should this meet with the
approbation of the Society.

A FEW lemmas and corollaries have been introduced that are
not among Dr STEWART's Theorems, and which are therefore dis-
tinguished by asterisks. The references are to the edition of
those Theorems published at Edinburgh, 1746, and the propo-
sitions are numbered as in that edition, beginning with the sixth
Theorem.

T H E-

THEOREM VI. FIG. I.

Let there be any number, m , of given points A, B, C , &c. a point X may be found, such, that if from A, B, C , &c. there be drawn straight lines to any point D , and to the point X found, and if DX be joined,

$$AD^2 + BD^2 + CD^2 \text{ \&c. } = AX^2 + BX^2 + CX^2 \text{ \&c. } + mDX^2.$$

LET m be = 3.

SUPPOSE the point X found, join DX , from the given points A, B, C draw AE, BF, CG perpendicular to DX , and join AX, BX, CX .

SINCE $AD^2 + BD^2 + CD^2 = AX^2 + BX^2 + CX^2 + 3DX^2$, and

$$AD^2 = AX^2 + DX^2 - 2DX \cdot XE, \text{ and}$$

$$BD^2 = BX^2 + DX^2 + 2DX \cdot XF, \text{ and}$$

$CD^2 = CX^2 + DX^2 + 2DX \cdot XG$, the point X in the line DX must be so taken, that the part EX , intercepted between it and AE the perpendicular from the point A , be equal to FX and GX , the sum of the parts intercepted between it and the perpendiculars BF and CG , from B and C ; and the parts FX, GX must be in the opposite direction to EX .

THIS will be effected by the following construction:

JOIN AB , and bisect it in H ; and join HC , and divide it in X , so that $CX = 2HX$; X will be the point required.

FROM H draw to DX the perpendicular HK .

SINCE $AH = BH$, we shall have $EK = FK$; and since $CX = 2HX$, we shall also have $GK = 2KX$. Therefore since

$$FX = FK - KX, \text{ and}$$

$$GX = 2KX$$

$$FX + GX = FK + KX = EK + KX = EX, \text{ and}$$

$$-2DX \cdot XE + 2DX \cdot XF + 2DX \cdot XG = 0.$$

THE point X thus found is the centre of gravity of the three points A, B, C . This proposition, and that which follows, are well known, and are given here only for the sake of order.

Dr SIMSON, in his Restoration of the Loci Plani, has deduced them from a proposition of that book. *Vid. Loc. Plan. lib. 2. prop. 5. cor. 1. & 3.* The second and fourth of Dr STEWART's Theorems are particular cases of this proposition, and are easily derived from it.

THEOREM VII. FIG. II.

Let there be any number, m , of given points $A, B, C, \&c.$ and let $a, b, c, \&c.$ be given magnitudes, as many in number as there are given points, a point X may be found, such, that if from $A, B, C, \&c.$ there be drawn straight lines to any point D , and also to X the point found, and if DX be joined,

$$a.AE^2 + b.BD^2 + c.CD^2 + \&c. = a.AX^2 + b.BX^2 + c.CX^2 + (a+b+c)DX^2.$$

LET m be $= 3$. Suppose the point X found. Join DX ; from the given points A, B, C draw AE, BF, CG perpendicular to DX , and join AX, BX, CX .

SINCE $a.AD^2 + b.BD^2 + c.CD^2 = a.AX^2 + b.BX^2 + c.CX^2 + (a+b+c)DX^2$; and

$$a.AD^2 = a.AX^2 + a.DX^2 - 2a.DX.XE, \text{ and}$$

$$b.BD^2 = b.BX^2 + b.DX^2 + 2b.DX.XF, \text{ and}$$

$$c.CD^2 = c.CX^2 + c.DX^2 + 2c.DX.XG; \text{ or}$$

$$a.AD^2 + b.BD^2 + c.CD^2 = a.AX^2 + b.BX^2 + c.CX^2 + (a+b+c)DX^2 + 2DX(-a.XE + b.XF + c.XG);$$

$a.XE$ must be equal, and in the opposite direction to $b.XF + c.XG$.

THIS will be effected by the following construction:

JOIN AB , and divide it in H , so that $b.BH = a.AH$; that is, make $AH : BH = b : a$, and join HC , and divide it in X , so that $HX : CX = c : a+b$; or $(a+b)HX = c.CX$. Then X will be the point required.

FROM H draw to DX , the perpendicular HK .

SINCE

SINCE $a.AH = b.BH$, we shall have $a.EK = b.FK$; and since $(a+b)HX = c.CX$, we shall also have $(a+b)KX = c.GX$. Therefore since

$$b.XF = b.FK - b.KX, \text{ and}$$

$$c.XG = (a+b)KX, \text{ we shall have}$$

$$b.XF + c.XG = b.FK + a.KX = a.EK + a.KX = a.XE, \text{ and}$$

$$2DX (-a.XE + b.XF + c.XG) = 0; \text{ therefore}$$

$$a.AD^2 + b.BD^2 + c.CD^2 = a.AX^2 + b.BX^2 + c.CX^2 + (a+b+c)DX^2, \text{ or}$$

$$AD^2 + \frac{b}{a}BD^2 + \frac{c}{a}CD^2 = AX^2 + \frac{b}{a}BX^2 + \frac{c}{a}CX^2 + \left(\frac{a+b+c}{a}\right)DX^2.$$

The point X is the centre of gravity of weights, proportional to the magnitudes a, b, c , &c. placed at the given points A, B, C, &c.

Cor. 1. LET any number, m , of circles be given by position, (fig. 3.) and about every circle let an equilateral figure be described, a point X may be found, such, that if from any point C there be drawn perpendiculars to the sides of the figures, and a straight line to the point found, twice the sum of the squares of the perpendiculars will be equal to the multiple of the square of the line drawn to the point found, by the number of the sides of the figures, together with a given space.

LET m be $= 2$; let a be the number of the sides of the figure described about the circle whose centre is A, b the number of the sides of the figure described about the circle whose centre is B, CD, CE, CF, the perpendiculars to the sides of the first figure, and CG, CH, CK, CL, the perpendiculars to the sides of the second.

JOIN the centres A, B, and divide AB in X, so that $AX : BX = b : a$, X will be the point required.

$$2(CD^2 + CE^2 + CF^2) = 2a.AM^2 + a.AC^2 \text{ (theor. 3.)}. \text{ In like manner,}$$

$$2(CG^2 + CH^2 + CK^2 + CL^2) = 2b.BN^2 + b.BC^2. \text{ Therefore,}$$

$$2(CD^2 + CE^2 + CF^2 + CG^2 + CH^2 + CK^2 + CL^2) = 2a.AM^2 + 2b.BN^2$$

$$+ a.AC^2 + b.BC^2. \text{ But,}$$

$$p \ 2$$

$$a.AC^2$$

$a.AC^2 + b.BC^2 = (a+b) AX.BX + (a+b) CX^2$ (prop. 1.), and $2a.AM^2 + 2b.BN^2 + (a+b) AX.BX$ are given spaces. Therefore $2(CD^2 + CE^2 + CF^2 + CG^2 + CH^2 + CK^2 + CL^2) = (a+b) CX^2 + A^2$, A^2 being a given space.

Cor. 2. LET any number of femicircles be given by position, and let an equilateral figure be described about every femicircle, a point may be found, such, that if from any point there be drawn perpendiculars to all the sides of the figures, and a straight line to the point found, twice the sum of the squares of the perpendiculars will be equal to the multiple of the square of the line drawn to the point found, by the number of all the sides, together with a given space.

Cor. 3. LET any number of circles and femicircles be given by position, and about every circle and femicircle let an equilateral figure be described, a point may be found, such, that if from any point there be drawn perpendiculars to all the sides of the figures, and a straight line to the point found, twice the sum of the squares of the perpendiculars will be equal to the multiple of the line drawn to the point found, by the number of the sides, together with a given space.

THEOREM VIII. FIG. IV.

Let there be any number, m , of given points A, B, C, &c. two points X, Y, may be found, such, that if from any point D straight lines be drawn to A, B, C, &c. and to X, Y,

$$2(DA^2 + DB^2 + DG^2) = m(DX^2 + DY^2).$$

THIS proposition follows directly from theor. 6. Let $m = 3$, and let E be the centre of gravity of the three points A, B, C. The squares of EA, EB, EC, are given, and consequently a square $= \frac{1}{3}(EA^2 + EB^2 + EC^2)$ may be found. On E with the distance EX
equal

equal to the side of this square, describe a circle. The extremities X, Y, of any diameter, will be two such points as are required. For

$$DA^2 + DB^2 + DC^2 = EA^2 + EB^2 + EC^2 + 3 \cdot ED^2, \quad (\text{Theor. 6.}).$$

But $EA^2 + EB^2 + EC^2 = 3 \cdot EX^2$, therefore

$$2(DA^2 + DB^2 + DC^2) = 6(EX^2 + ED^2) = 3(DX^2 + DY^2)$$

(Prop. 1.).

THEOREM IX. FIG. IV.

Let there be any number, m, of given points A, B, C, &c. and let a, b, c, &c. be given magnitudes, as many in number as there are given points, two points X, Y, may be found, such, that if from any point D there be drawn straight lines to A, B, C, &c. and to X, Y,

$$DA^2 + \frac{b}{a}DB^2 + \frac{c}{a}DC^2 \text{ \&c.} = \left(\frac{a+b+c}{2a}\right)(DX^2 + DY^2).$$

THIS proposition follows, in the same manner, from theor. 7.

Let m be = 3. Let E be a point such that $DA^2 + \frac{b}{a}DB^2 +$

$$\frac{c}{a}DC^2 = EA^2 + \frac{b}{a}EB^2 + \frac{c}{a}EC^2 + \left(\frac{a+b+c}{a}\right)ED^2. \quad \text{On E as a}$$

centre, with the distance $EX = \sqrt{\frac{a}{a+b+c}(EA^2 + \frac{b}{a}EB^2 + \frac{c}{a}EC^2)}$

describe a circle. The extremities X, Y, of any diameter, will be two such points as are required. For

$$DA^2 + \frac{b}{a}DB^2 + \frac{c}{a}DC^2 = EA^2 + \frac{b}{a}EB^2 + \frac{c}{a}EC^2 + \left(\frac{a+b+c}{a}\right)ED^2,$$

$$\text{and } EA^2 + \frac{b}{a}EB^2 + \frac{c}{a}EC^2 = \left(\frac{a+b+c}{a}\right)EX^2. \quad \text{Therefore,}$$

$$2(DA^2$$

$$2\left(DA^2 + \frac{b}{a}DB^2 + \frac{c}{a}DC^2\right) = 2\left(\frac{a+b+c}{a}\right)(ED^2 + EX^2) =$$

$$\left(\frac{a+b+c}{a}\right)(DX^2 + DY^2), \quad (\text{Prop. 1.}). \quad \text{Or,}$$

$$DA^2 + \frac{b}{a}DB^2 + \frac{c}{a}DC^2 = \left(\frac{a+b+c}{2a}\right)(DX^2 + DY^2).$$

THEOREM X. FIG. V.

Let there be any number, m , of parallel straight lines AB, CD, EF, &c. given by position, a straight line XY may be found parallel to them, such, that if from any point G, perpendiculars GA, GC, GE, &c. be drawn to AB, CD, EF, &c. and the line GX perpendicular to XY,

$$GA^2 + GC^2 + GE^2 \text{ \&c. } = mGX^2 + A^2, \quad A^2 \text{ being a given space.}$$

THIS proposition is one of the simplest cases of theor. 6. A line XY parallel to AB, drawn through X, the centre of gravity of the points A, C, E, where a perpendicular from G meets the parallels AB, CD, EF, will be the line required. For,

$$GA^2 + GC^2 + GE^2 = XA^2 + XC^2 + XE^2 + 3GX^2 \quad (\text{Theor. 6.}), \text{ and} \\ XA^2 + XC^2 + XE^2 \text{ is a given space.}$$

THEOREM XI. FIG. VI.

Let there be any number, m , of straight lines AB, AC, AD, &c. intersecting in a point A, so as to make all the angles round it equal; and from any point E, let perpendiculars EB, EC, ED, &c. be drawn to AB, AC, AD, &c. and let AE be joined,

$$2(EB^2 + EC^2 + ED^2 \text{ \&c. }) = m.EA^2.$$

THIS

THIS proposition follows directly from the first case of theor. 2. Let m be $= 3$. The points B, C, D, are in a circle of which EA is the diameter, and therefore (lemma 2.) the arches BC, CD, DB, are equal. Therefore,

$$2(EB^2 + EC^2 + ED^2) = 4 \cdot 3 \cdot R^2 = 3 \cdot EA^2 \dagger.$$

Cor. 1. IF AB, AC, AD, intersect one another in a given point A, and make all the angles round it equal; and if from any point E there be drawn perpendiculars to AB, AC, AD; and if the sum of the squares of the perpendiculars be equal to a given space, the point E will be in the circumference of a given circle.

THE double of the given space is $m \cdot AE^2$, therefore AE is given in magnitude, and since the point A is given, the point E is in the circumference of a given circle.

* *Cor. 2.* IF the circumference of a circle FGH, of which the radius is R, be divided into m number of equal parts, by the femidiameters AF, AG, AH, &c. making with any diameter EN the angles FAE, GAN, HAE, &c. twice the sum of the squares of the sines, or cosines of these angles will be $= mR^2$.

LET m be $= 3$.

FK = EB; GL = EC; HM = ED. Therefore $2(FK^2 + GL^2 + HM^2) = 3EA^2 = 3R^2$. In the same manner, AK = AB; AL = AC; AM = AD. Therefore $2(AK^2 + AL^2 + AM^2) = 3 \cdot EA^2 = 3R^2$.

* L E M M A III. FIG. VII.

Let there be a figure ABCD given in species inscribed in a circle, the straight line EH drawn from E, the centre of the circle, to H, the

† R is the radius of the circle ABC.

the centre of gravity of the figure, will have a given ratio to the semidiameter, and will make given angles with the semidiameters, drawn to the angular points of the figure.

THE centre of gravity of the figure ABCD is found by bisecting AB in F, by joining FC and dividing it in G, so that $CG = 2GF$, and by joining GD and dividing it in H, so that $DH = 3HG$. Hence, and by joining BD and CA, the lemma will be manifest.

FOR the triangle BFE is right-angled in F, and the angle BEF = ADB, is given. Therefore the ratio of BE, or CE, to EF is given.

AGAIN, in the triangle CEF, the angle CEF = BEC + BEF = 2BDC + ADB = a given angle; and since the ratio of CE to EF, and of CG to GF are given, the line EG will divide the triangle CFE into two triangles given in species. Therefore the angle CEG, and the ratio of CE, or DE, to EG, are given.

LASTLY, in the triangle DEG, the angle DEG = 2DAC + CEG, is given; and since the ratio of DE to EG, and of DH to HG, are given, the line EH will divide the triangle DEG into two triangles given in species. Therefore the angle DEH, and the ratio of DE to EH will be also given.

THEOREM XII. FIG. VIII.

Let there be any number, m, of straight lines AB, AC, AD, AE, &c. given by position, intersecting one another in the point A, two straight lines AX, AY, may be found, which will be given by position, such, that if from any point F there be drawn the perpendiculars FB, FC, FD, FE, &c. to AB, AC, AD, AE, &c. and FX, FY, perpendicular to AX, AY,

$$2(FB^2 + FC^2 + FD^2 + FE^2 \text{ \&c.}) = m(FX^2 + FY^2).$$

LET

LET m be $= 4$. Let G be the centre of the circle which passes through A, B, C, D, E, F , and H the centre of gravity of the figure $BCDE$. Join GH , and through H draw XHY perpendicular to GH , meeting the circumference in X, Y , and join $GB, GC, GD, GE; HB, HC, HD, HE, HF; AX, AY, FX, FY$. Then, by Theor. 6. $GB^2 + GC^2 + GD^2 + GE^2 = 4GB^2 = HB^2 + HC^2 + HD^2 + HE^2 + 4HG^2$.

But $4GB^2 = 4GX^2 = 4(GH^2 + XH^2)$. Therefore also, $HB^2 + HC^2 + HD^2 + HE^2 + 4HG^2 = 4(HG^2 + HX^2)$; or, $HB^2 + HC^2 + HD^2 + HE^2 = 4HX^2$. Again, by Theor. 6. $FB^2 + FC^2 + FD^2 + FE^2 = HB^2 + HC^2 + HD^2 + HE^2 + 4FH^2$, and therefore,

$FB^2 + FC^2 + FD^2 + FE^2 = 4(FH^2 + HX^2)$. That is,
 $2(FB^2 + FC^2 + FD^2 + FE^2) = 8(FH^2 + HX^2) = 4(FX^2 + FY^2)$,
 (Prop. 1.).

BUT because the lines AB, AC, AD, AE , are given by position, the angles BAC, CAD, DAE, BAE , are given; therefore the angles BGC, CGD, DGE, BGE , which are the doubles of them, are also given, and the isosceles triangles BGC, CGD, DGE, BGE , are given in species. Consequently, the ratio of the semidiameter GB to each of the lines BC, CD, DE, BE , is given, and therefore the ratios of BC, CD, DE, BE , to one another, are given; and the angles of the figure $BCDE$ are also given, therefore the figure itself is given in species. Therefore (Lemma 3.) the ratio of GX to GH is given; and since the angle GHX is a right angle, the triangle GHX is given in species. Therefore the angles XGH, YGH , are given. But BGH is given, (Lemma 3.); therefore BGX, BGY , and their halves BAX, BAY , are also given; and since BA is given by position, and the point A , the lines AX, AY , are also given by position.

BUT FX, FY , are perpendicular to AX, AY , and it has been shewn that $2(FB^2 + FC^2 + FD^2 + FE^2) = 4(FX^2 + FY^2)$. Therefore AX, AY , are the two lines required to be found.

THE construction is obvious, by assuming a point F , which, for the greater simplicity, may be in one of the given lines, and by describing the figure as above.

* *Cor.* If from any point parallels be drawn to AB, AC, AD, AE , and to AX, AY , cutting the perpendiculars FB, FC, FD, FE , and FX, FY , in b, c, d, e , and in x, y ,

$$2(Fb^2 + Fc^2 + Fd^2 + Fe^2) = 4(Fx^2 + Fy^2).$$

* L E M M A IV. FIG. IX.

Let AB, AC , be two straight lines given by position, intersecting one another in the point A , and from any point D let DB, DC , be drawn perpendicular to AB, AC ; let CB be joined, and bisected in E , and from E let EF be drawn parallel, and equal to a given straight line; through F let GFH be drawn to meet DB and DC , so as to be bisected in F , and through G and H let GK, HK , be drawn parallel to AB, AC : the lines GK, HK , will be given by position.

THROUGH F draw LM parallel to BC , and through B and C draw BL and CM parallel to EF ; join GL, HM ; from A draw AN parallel and equal to EF ; join LN, MN ; through N draw OP parallel to GL ; and join AO, AP .

BECAUSE $GF = FH$, and $LF = FM$, GL will be equal and parallel to HM ; and because AN is equal and parallel to BL and to CM , the figures AM and AL are parallelograms. Therefore NL is parallel to GK , and NM to HK . Therefore NG and NH are parallelograms, and $OG = NL = AB$; hence AO is perpendicular to GK ; and, in the same manner, AP is perpendicular

dicular to HK. Therefore $NO = LG = HM = NP$. But the angle OAP is given, being the supplement of OKP; and since the point N is given, and $NO = NP$, the points O and P are given; and therefore AO and AP. Therefore the lines GK, HK, are given by position.

THEOREM XIII. FIG. X. No. 1.

Let there be any number, m , of straight lines AB, BC, CD, DA, &c. given by position, neither all parallel nor intersecting in one point, two straight lines XY, XZ, may be found, which will be given by position, such, that if from any point E, there be drawn perpendiculars EF, EG, EH, EK, &c. to AB, BC, CD, DA, &c. and EY, EZ, perpendicular to XY, XZ,

$$2(EF^2 + EG^2 + EH^2 + EK^2 \text{ \&c.}) = m(EY^2 + EZ^2) + A^2,$$

A^2 being a given space.

LET $m = 4$, and from C, one of the points of intersection, draw Cf, Ck, parallel to the lines given by position that do not intersect in C. Let two straight lines CL, CM be found, such, that $2(Ef^2 + EG^2 + EH^2 + Ek^2) = 4(EL^2 + EM^2)$, (Theor. 12.). Let N be the centre of gravity of the four points F, G, H, K, (Theor. 6.). Through N draw YNZ to meet EL, EM in Y, Z, and so as to be bisected in N. Through Y and Z draw YX, ZX perpendicular to EL, EM, intersecting each other in X. From X draw XP, XQ, XR, XS, perpendicular, and Xa, Xb, Xc, Xd, parallel to AB, BC, CD, DA; let Xa, Xb, Xc, Xd, meet EF, EG, EH, EK, in a, b, c, d; join XF, XG, XH, XK; NF, NG, NH, NK, NX; and let O be the centre of gravity of the four points f, G, H, k, where the parallels from C, to the lines given by position, meet the perpendiculars from E.

By theor. 6. $2(XF^2 + XG^2 + XH^2 + XK^2) = 2(NF^2 + NG^2 + NH^2 + NK^2) + 8NX^2$. But $2(XF^2 + XG^2 + XH^2 + XK^2) = 2(XP^2 + XQ^2 + XR^2 + XS^2) + 2(Xa^2 + Xb^2 + Xc^2 + Xd^2)$. Therefore $2(NF^2 + NG^2 + NH^2 + NK^2) + 8NX^2 = 2(XP^2 + XQ^2 + XR^2 + XS^2) + 2(Xa^2 + Xb^2 + Xc^2 + Xd^2)$. But since, $2(Ef^2 + EG^2 + EH^2 + Ek^2) = 4(EL^2 + EM^2)$, and from the point X parallels to Cf, CG, CH, Ck, and to CL, CM, are drawn, cutting the perpendiculars from E, to these lines, in a, b, c, d , and in Y, Z, therefore, by Cor. Theor. 12.

$2(Ea^2 + Eb^2 + Ec^2 + Ed^2) = 4(EY^2 + EZ^2)$, and consequently $2(Xa^2 + Xb^2 + Xc^2 + Xd^2) = 4(XY^2 + XZ^2) = 8(NY^2 + NX^2)$, (Prop. 1.). Therefore,

$2(NF^2 + NG^2 + NH^2 + NK^2) = 2(XP^2 + XQ^2 + XR^2 + XS^2) + 8NY^2$. But by Theor. 6.

$2(EF^2 + EG^2 + EH^2 + EK^2) = 2(NF^2 + NG^2 + NH^2 + NK^2) + 8NE^2$. Therefore,

$2(EF^2 + EG^2 + EH^2 + EK^2) = 2(XP^2 + XQ^2 + XR^2 + XS^2) + 8(NY^2 + NE^2)$; or,

$2(EF^2 + EG^2 + EH^2 + EK^2) = 2(XP^2 + XQ^2 + XR^2 + XS^2) + 4(EY^2 + EZ^2)$, (Prop. 1.).

It remains to demonstrate that X is a given point, and that XY, XZ, are lines given in position.

THE point O may be found, by bisecting (Fig. X. No. 2.) GH in g , joining gk , and dividing it in m , so that $gm = \frac{1}{3}gk$, and joining fm and dividing it in O, so that $mO = \frac{1}{4}mf$; and in the same manner the point N may be found by joining gK , and making $gn = \frac{1}{3}gK$, and joining nF , and making $nN = \frac{1}{4}nF$; let mn be joined, through O draw Op , and through N draw Nq , both parallel to EF, and meeting mn in p, q ; let EF meet mn in r , join ON, and through O draw Or parallel to mn , meeting Nq in s .

THEN because $gm = \frac{1}{3}gk$, and $gn = \frac{1}{3}gK$, the line mn is parallel and equal to $\frac{1}{3}Kk$. Because also $Nn = \frac{1}{4}Fn$, $Nq = \frac{1}{4}Fr$; and

and for the same reason $OP = \frac{1}{4}fr$. Therefore $pq = Or = \frac{1}{4}mn = \frac{1}{4}Kk$. But the angle OrN is given, for it is equal to $\angle EF$; and since Or is given, and $Nr = Nq - sq$, NO is also given. But (Fig. 10. No. 1.) since the lines CL, CM , intersecting in the point C , are given by position, and from the point E there are drawn to them the perpendiculars EL, EM , and LM is joined, and bisected in O , and from O there is drawn a straight line ON given both by position and magnitude, and YNZ is drawn through N to meet EL, EM in Y, Z , and so as to be bisected in N , and from Y and Z , YX, ZX are drawn parallel to CL, CM ; therefore, by Lemma 4. YX, ZX are given by position; and consequently the point X , of their intersection is given, and therefore also XP, XQ, XR, XS .

BUT EY, EZ , are perpendicular to XY, XZ ; and it has been proved that $2(EF^2 + EG^2 + EH^2 + EK^2) = 4(EY^2 + EZ^2) + 2(XP^2 + XQ^2 + XR^2 + XS^2)$, and these four last squares are given. Therefore XY, XZ , are the two lines required to be found, and $2(EF^2 + EG^2 + EH^2 + EK^2) = 4(EY^2 + EZ^2) + A^2$.

THE point X , found in this proposition, is the centre of gravity of the four points P, Q, R, S , where perpendiculars, drawn from it, meet the four lines given by position. It is also a point, such, that the sum of the squares of the perpendiculars drawn from it, to the lines given by position, is a minimum.

Cor. If the straight lines (Fig. 11.) AB, BC, CA , be so situated as to form an equilateral figure about a circle, or a semicircle; or if the number of the lines given by position be even, and every two and two intersect each other at right angles, the two lines XY, XZ , that may be found, will intersect each other at right angles.

LET the lines AB, BC, CA , that are given by position, form an equilateral triangle. Let X be the point in that triangle, which is the centre of gravity of the three points K, L, M ,
where:

where perpendiculars drawn from it, meet the lines given by position; and from X let parallels be drawn to these lines, meeting the perpendiculars from any point E in f, g, b .

SINCE these parallels Xf, Xg, Xb , intersect one another in the point X, so as to make all the angles round it equal, they will divide the circumference of the circle which passes through X and E, into three equal arches fg, gb, bf , (Lemma 2.). Therefore N, the centre of the circle, is the centre of gravity of the three points f, g, b , and the line YZ, passing through N, and meeting the circumference, will be a diameter of the circle, and therefore YXZ is a right angle.

THEOREM XIV. FIG. XII. &c.

Let any number, m , greater than 3, of straight lines be given by position, three straight lines may be found, which will be given by position, such, that if from any point there be drawn perpendiculars to the lines given by position, and to the three lines found, thrice the sum of the squares of the perpendiculars to the lines given by position, will be equal to the sum of the squares of the perpendiculars drawn to three lines found, multiplied by the number m .

LET m be = 4.

Case 1. WHEN the lines (Fig. 12.) AF, BG, CH, DK, given by position, are all parallel. Let a perpendicular from any point E meet the parallels in the points A, B, C, D, and let L be the centre of gravity of these points. Assume in AL any point X, and let Y and Z, on the opposite side of L, be such, that $LY + LZ = LX$, and also $LX^2 + LY^2 + LZ^2 = \frac{3}{4}(LA^2 + LB^2 + LC^2 + LD^2)$; then if the assumed point X be given, the points Y and Z will also be given. Draw through the points X, Y, Z, straight lines parallel to AF, and they will be the lines required.

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It is plain that L is the centre of gravity of the points X, Y, Z, and because it is also the centre of gravity of the points A, B, C, D,

$$3(EA^2+EB^2+EC^2+ED^2) = 3(LA^2+LB^2+LC^2+LD^2) + 3 \cdot 4 \cdot EL^2, \text{ (Theor. 6.)}; \text{ and, for the same reason,}$$

$$4(EX^2+EY^2+EZ^2) = 4(LX^2+LY^2+LZ^2) + 4 \cdot 3 \cdot EL^2.$$

But by construction,

$$3(LA^2+LB^2+LC^2+LD^2) = 4(LX^2+LY^2+LZ^2). \text{ Therefore,}$$

$$3(EA^2+EB^2+EC^2+ED^2) = 4(EX^2+EY^2+EZ^2).$$

Case 2. WHEN the lines (Fig. 13.) AB, AC, AD, AE, given by position, intersect one another in the same point A.

LET G be the centre of gravity of the four points B, C, D, E, in the circumference of the circle of which AF is the diameter, (Theor. 6.), and let AH, AK, be two lines, whose position is given, such, that $2(FB^2+FC^2+FD^2+FE^2) = 4(FH^2+FK^2)$, (Theor. 12.). From any point X in the circumference draw, through G, the line XGL, so that $XG = 2GL$; and through L draw YLZ to meet the circumference in Y, Z, and so as to be bisected in L. Join AX, AY, AZ, and FX, FY, FZ.

$3(FB^2+FC^2+FD^2+FE^2) = 6(FH^2+FK^2)$, (Theor. 12.), and $4(FX^2+FY^2+FZ^2) = 6(FH^2+FK^2) = 3(FB^2+FC^2+FD^2+FE^2)$. Therefore AX, AY, AZ, are the three lines required to be found.

Case 3. WHEN the lines (Fig. 14. No. 1.) AB, BC, CD, DA, are not parallel, and do not intersect one another in the same point.

LET X be a point so related to the lines AB, BC, CD, DA, that it shall be the centre of gravity of the four points L, M, N, O, where they are intersected by the perpendiculars XL, XM, XN, XO, drawn to them from X, (Theor. 13.); and let XP, XQ, XR, XS, be drawn from X parallel to AB, BC, CD, DA, and let them meet the perpendiculars to these lines, from E, in P,

P, Q, R, S. Let Xa, Xb, Xc , be three straight lines, such, that $3(EP^2 + EQ^2 + ER^2 + ES^2) = 4(Ea^2 + Eb^2 + Ec^2)$, (Case 2. of this). Describe a triangle def , (Fig. 14. No. 2.) having the angle $def = aXb$, and the angle $dfe = bXc$. Let g be a point in that triangle, such, as to be the centre of gravity of the three points b, k, l , where perpendiculars drawn from it meet the sides, (Theor. 13.). Describe a square $= \frac{1}{4}(XL^2 + XM^2 + XN^2 + HO^2)$, and divide it into three squares whose sides Xm, Xn, Xo , shall have the mutual ratios of gb, gk, gl . Through X draw Xm, Xn, Xo , perpendicular to Xa, Xb, Xc , and through m, n, o , draw mp, nq, qp , perpendicular to Xm, Xn, Xo , and meeting Ea, Eb, Ec , in x, y, z . We have, by Theor. 13.

$$3(EF^2 + EG^2 + EH^2 + EK^2) = 3(EP^2 + EQ^2 + ER^2 + ES^2) + 3(XL^2 + XM^2 + XN^2 + XO^2), \text{ and also}$$

$$4(Ex^2 + Ey^2 + Ez^2) = 4(Ea^2 + Eb^2 + Ec^2) + 4(Xm^2 + Xn^2 + Xo^2).$$

But by construction,

$$3(EP^2 + EQ^2 + ER^2 + ES^2) = 4(Ea^2 + Eb^2 + Ec^2), \text{ and by Case 2. of this, } 3(XL^2 + XM^2 + XO^2 + XN^2) = 4(Xm^2 + Xn^2 + Xo^2).$$

Therefore,

$$3(EF^2 + EG^2 + EH^2 + EK^2) = 4(Ex^2 + Ey^2 + Ez^2). \text{ Therefore } mp, nq, qp, \text{ are the lines required to be found.}$$

THE three lines found in this Theorem are determined, in their position, only relatively to one another, and not absolutely; because, in the construction of each of the cases, an arbitrary supposition is unavoidably introduced, and of consequence there are innumerable sets of lines, within certain limits however, that all equally answer the conditions required in the proposition. When one of these is assumed as given in position, the other two are necessarily determined.

THE four propositions which follow in Dr STEWART's book are extensions of four that have already been demonstrated here, *viz.* the 10th, 12th, 13th and 14th; and are related to them just as the 7th of the preceding is to the sixth, or the 9th to the 8th. The purpose of them is to apply what has been demonstrated

demonstrated of the squares of the perpendiculars in Prop. 10. &c. to any rectilineal figures whatever, each given in species, described on those perpendiculars.

THEIR demonstrations are all derived in the same manner from those of their corresponding propositions, and it will therefore be sufficient, at present, to give the demonstration of one of them. I have made choice of the 16th, as the 15th is only the simplest case of the 7th, *viz.* when all the points given, in that Theorem, are in the same straight line.

THEOREM XVI. FIG. VIII.

Let there be any number, m , of straight lines AB, AC, AD, AE, &c. given by position, intersecting one another in the point A, and let a, b, c, d , &c. be given magnitudes, as many in number as there are lines given by position, two straight lines AX, AY, may be found, which will be given by position, such, that if from any point F there be drawn FB, FC, FD, FE, &c. perpendicular to AB, AC, AD, AE, &c. and FX, FY, perpendicular to AX, AY,

$$FB^2 + \frac{b}{a} FC^2 + \frac{c}{a} FD^2 + \frac{d}{a} FE^2 \text{ \&c.} = \frac{a+b+c+d \text{ \&c.}}{2a} (FX^2 + FY^2).$$

LET $m = 4$. Let G be the centre of the circle which passes through the points A, B, C, D, E and F; and let H be the centre of gravity of weights proportional to the magnitudes a, b, c, d , placed at the points B, C, D and E. Join GH; and let XY, at right angles to GH in H, meet the circumference of the circle ABDF in X and Y: AX, AY, are the lines required to be found.

FOR it may be shown, just as in Theor. 12. by means of a lemma similar to the 3d, that AX and AY make given angles

with AB, and are therefore given in position. But by Theor. 7.

$$GB^2 + \frac{b}{a} GC^2 + \frac{c}{a} GD^2 + \frac{d}{a} GE^2 = \frac{a+b+c+d}{a} GX^2 =$$

$$HB^2 + \frac{b}{a} HC^2 + \frac{c}{a} HD^2 + \frac{d}{a} HE^2 = \frac{a+b+c+d}{a} GH^2. \text{ Now,}$$

$$\frac{a+b+c+d}{a} GX^2 = \frac{a+b+c+d}{2a} (GX^2 + GY^2) =$$

$$\frac{a+b+c+d}{a} (GH^2 + HX^2), \text{ by Prop. 1. Therefore,}$$

$$HB^2 + \frac{b}{a} HC^2 + \frac{c}{a} HD^2 + \frac{d}{a} HE^2 = \frac{a+b+c+d}{a} HX^2.$$

$$\text{AGAIN, by Theor. 7. } FB^2 + \frac{b}{a} FC^2 + \frac{c}{a} FD^2 + \frac{d}{a} FE^2 =$$

$$HB^2 + \frac{b}{a} HC^2 + \frac{c}{a} HD^2 + \frac{d}{a} HE^2 + \frac{a+b+c+d}{a} HF^2; \text{ therefore,}$$

$$FB^2 + \frac{b}{a} FC^2 + \frac{c}{a} FD^2 + \frac{d}{a} FE^2 = \frac{a+b+c+d}{a} (HX^2 + HF^2), \text{ or, since}$$

$$HX^2 + HF^2 = \frac{1}{2} (FX^2 + FY^2), \quad FB^2 + \frac{b}{a} FC^2 + \frac{c}{a} FD^2 + \frac{d}{a} FE^2 =$$

$$\frac{a+b+c+d}{2a} (FX^2 + FY^2).$$

Cor. If from any point, as F, straight lines be drawn in given angles to the lines which are given by position, and which intersect in one point, two straight lines may be found which will be given by position, such, that if perpendiculars from F be drawn to them, the sum of the squares of the lines drawn in given angles, will be equal to the space to which the sum of the squares of the perpendiculars has a given ratio.

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THIS corollary is evident, because the lines drawn from F, making given angles with AB, AC, &c. will have given ratios to the perpendiculars FB, FC, &c.

THE 17th Theorem is, *That if a, b, c, &c. be any magnitudes as above, and if the figure be constructed as in Theor. 13. (Fig. 10.),*

$$EF^2 + \frac{b}{a} EG^2 + \frac{c}{a} EH^2 + \frac{d}{a} EK^2 \text{ \&c.} = \frac{a+b+c+d+\text{\&c.}}{2a} (EY^2 + EZ^2) + A^2, \text{ } A^2 \text{ being a given space.}$$

This is demonstrated from its relation to the 13th, in the same manner with the preceding, and so also is the 18th from the 14th. The 18th is, *That if a, b, c, &c. be any given magnitudes, and if the same things be supposed as in Theor. 14. (Fig. 14.) three straight lines mp, nq, qp,*

may be found, such, that $EF^2 + \frac{b}{a} EG^2 + \frac{c}{a} EH^2 + \frac{d}{a} EK^2, \text{ \&c.} =$

$$\frac{a+b+c+d+\text{\&c.}}{3a} (Ex^2 + Ey^2 + Ez^2).$$

WE proceed now to a proposition that relates to the fourth powers of the perpendiculars.

THEOREM XXVII. FIG. XV.

Let there be any number, m, of given points A, B, C, &c. two straight lines may be found, which will be given by position, and likewise a point D, such, that if from any point E, there be drawn EY, EZ, perpendicular to the two lines found, and if EA, EB, EC, &c. and ED be joined, then, (making $A^2 = a$ given space, and $B^4 =$ the fourth power of a given line.)

$$AE^4 + BE^4 + CE^4 \text{ \&c.} = mDE^4 + A^2(EY^2 + EZ^2) + B^4.$$

Let m be $= 3$. Let D be the centre of gravity of the three points A, B, C ; join AD, BD, CD ; from E draw EF, EG, EH perpendicular to AD, BD, CD ; in AD take $DK = \frac{1}{3}AD$, in BD take $DL = \frac{1}{3}BD$, and in CD take $DM = \frac{1}{3}CD$. Then,

$$AE^2 = DE^2 + AD^2 - 2AD.DF$$

$$BE^2 = DE^2 + BD^2 + 2BD.DG$$

$$CE^2 = DE^2 + CD^2 - 2CD.DH. \text{ Therefore,}$$

$$AE^4 = DE^4 + 2AD^2.DE^2 - 4AD^3.DF + AD^4 - 4DE^2.AD.DF + 4AD^2.DF^2.$$

$$BE^4 = DE^4 + 2BD^2.DE^2 + 4BD^3.DG + BD^4 + 4DE^2.BD.DG + 4BD^2.DG^2.$$

$$CE^4 = DE^4 + 2CD^2.DE^2 - 4CD^3.DH + CD^4 - 4DE^2.CD.DH + 4CD^2.DH^2. \text{ But because } D \text{ is the centre of gravity of the three points } A, B, C, AD.DF + CD.DH = BD.DG. \text{ Therefore, making } AE^4 + BE^4 + CE^4 = S^4, \text{ we shall have}$$

$$S^4 = 3DE^4 + 2 \left\{ \begin{matrix} AD^2.DE^2 \\ BD^2.DE^2 \\ CD^2.DE^2 \end{matrix} \right\} + 4 \left\{ \begin{matrix} -AD^3.DF \\ +BD^3.DG \\ -CD^3.DH \end{matrix} \right\} + 4 \left\{ \begin{matrix} AD^2.DF^2 \\ BD^2.DG^2 \\ CD^2.DH^2 \end{matrix} \right\} + \left\{ \begin{matrix} AD^4 \\ BD^4 \\ CD^4 \end{matrix} \right\}.$$

But $DE^2 = EF^2 + DF^2 = EG^2 + DG^2 = EH^2 + DH^2$. Therefore,

$$S^4 = 3DE^4 + 2 \left\{ \begin{matrix} AD^2.EF^2 \\ BD^2.EG^2 \\ CD^2.EH^2 \end{matrix} \right\} + 6 \left\{ \begin{matrix} AD^2.DF^2 \\ BD^2.DG^2 \\ CD^2.DH^2 \end{matrix} \right\} + 4 \left\{ \begin{matrix} -AD^3.DF \\ +BD^3.DG \\ -CD^3.DH \end{matrix} \right\} + \left\{ \begin{matrix} AD^4 \\ BD^4 \\ CD^4 \end{matrix} \right\}.$$

$$\text{Or, } S^4 = 3DE^4 + 2 \left\{ \begin{matrix} AD^2.EF^2 \\ BD^2.EG^2 \\ CD^2.EH^2 \end{matrix} \right\} + \left\{ \begin{matrix} AD^2(6DF^2 - 4AD.DF + AD^2) \\ BD^2(6DG^2 + 4BD.DG + BD^2) \\ CD^2(6DH^2 - 4CD.DH + CD^2) \end{matrix} \right\}.$$

But $3DK = AD$; $3DL = BD$, and $3DM = CD$; and consequently $9DK^2 = AD^2$, $9DL^2 = BD^2$, and $9DM^2 = CD^2$. Therefore, $S^4 = 3DE^4 +$

$$2 \left\{ \begin{matrix} AD^2.EF^2 \\ BD^2.EG^2 \\ CD^2.EH^2 \end{matrix} \right\} + \left\{ \begin{matrix} AD^2(6DF^2 - 12DK.DF + 6DK^2) \\ BD^2(6DG^2 + 12DL.DG + 6DL^2) \\ CD^2(6DH^2 - 12DM.DH + 6DM^2) \end{matrix} \right\} + \left\{ \begin{matrix} 3DK^2.AD^2 \\ 3DL^2.BD^2 \\ 3DM^2.CD^2 \end{matrix} \right\}.$$

Or,

$$\text{Or, } S^4 = 3DE^4 + 2 \left\{ \begin{matrix} AD^2.EF^2 \\ BD^2.EG^2 \\ CD^2.EH^2 \end{matrix} \right\} + 6 \left\{ \begin{matrix} AD^2.FK^2 \\ BD^2.LG^2 \\ CD^2.MH^2 \end{matrix} \right\} + \frac{1}{3} \left\{ \begin{matrix} AD^4 \\ BD^4 \\ CD^4 \end{matrix} \right\}.$$

JOIN EK, and on it as a diameter describe the circle KFPENQ, draw the diameter FN and divide it in O, so that FO = 3ON, and through O draw PQ perpendicular to FN, meeting the circumference in P, Q; and join KP, KQ; EP, EQ. In the same manner, join EL, and on it as a diameter describe the circle GVL RTE, draw the diameter GR, and divide it in S, so that GS = 3SR; through S draw TV perpendicular to GR, meeting the circumference in T, V; and join LT, LV, ET, EV. In the same manner also join EM, and on it as a diameter describe the circle HZEX^aM, draw the diameter HX, and divide it in Y, so that HY = 3YX; through Y draw Za perpendicular to HX, meeting the circumference in Z, ^a; and join MZ, Ma, EZ, Ea. Then, FK = EN; LG = ER; and MH = EX. Therefore,

$$S^4 = 3DE^4 + 2 \left\{ \begin{matrix} AD^2.EF^2 \\ BD^2.EG^2 \\ CD^2.EH^2 \end{matrix} \right\} + 6 \left\{ \begin{matrix} AD^2.EN^2 \\ BD^2.ER^2 \\ CD^2.EX^2 \end{matrix} \right\} + \frac{1}{3} \left\{ \begin{matrix} AD^4 \\ BD^4 \\ CD^4 \end{matrix} \right\}. \quad \text{But}$$

$2EF^2 + 6EN^2 = 8FO.ON + 8EO^2 = 8(OP^2 + EO^2) = 4(EP^2 + EQ^2)$. In the same manner, $2EG^2 + 6ER^2 = 8GS.SR + 8ES^2 = 8(TS^2 + ES^2) = 4(ET^2 + EV^2)$. In the same manner also, $2EH^2 + 6EX^2 = 8HY.YX + 8EY^2 = 8(ZY^2 + EY^2) = 4(EZ^2 + Ea^2)$. Therefore,

$$S^4 = 3DE^4 + 4 \left\{ \begin{matrix} AD^2(EP^2 + EQ^2) \\ BD^2(ET^2 + EV^2) \\ CD^2(EZ^2 + Ea^2) \end{matrix} \right\} + \frac{1}{3} \left\{ \begin{matrix} AD^4 \\ BD^4 \\ CD^4 \end{matrix} \right\}. \quad \text{Since then there}$$

are six straight lines KP, KQ, LT, LV, MZ, Ma, given by position, and given quantities $4AD^2$, $4AD^2$, $4BD^2$, $4BD^2$, $4CD^2$, $4CD^2$, as many in number as there are lines given by position, therefore, by Theor. 17. two straight lines, xy , xz , may be found, which will be given by position, such, that if from the point

point E, the perpendiculars EP, EQ, ET, EV, EZ, Ea, be drawn to KP, KQ, LT, LV, MZ, Ma, and if the perpendiculars Ey, Ez, be drawn to xy, xz, $4AD^2 \cdot EP^2 + 4AD^2 \cdot EQ^2 + 4BD^2 \cdot ET^2 + 4BD^2 \cdot EV^2 + 4CD^2 \cdot EZ^2 + 4CD^2 \cdot Ea^2 =$

$8(AD^2 + BD^2 + CD^2)(Ey^2 + Ez^2) + a^4$. Therefore,

$S^4 = 3DE^4 + A^2(Ey^2 + Ez^2) + a^4 + \frac{1}{3}(AD^4 + BD^4 + CD^4)$. Or,

$S^4 = 3DE^4 + A^2(Ey^2 + Ez^2) + B^4$.

Therefore xy, xz, are the lines, and D the point, required to be found.

THEOREM XXVIII.

Let there be any number, m, of given points A, B, C, &c. and let a, b, c, &c. be given magnitudes, as many in number as there are given points, two straight lines, xy, xz, may be found, which will be given by position, and likewise a point D, such, that if from any point E, there be drawn perpendiculars Ey, Ez, to the two lines found, and if EA, EB, EC, ED, be joined,

$$AE^2 + \frac{b}{a}BE^2 + \frac{c}{a}CE^2 \&c. = \frac{a+b+c+\&c.}{a}DE^2 + A^2(Ey^2 + Ez^2) + B^4.$$

THE investigation is perfectly similar to the former; only the point D is not the centre of gravity of the points A, B, C, &c. but, as in Theor. 7. the centre of gravity of weights, supposed to be placed in those points, and proportional to the magnitudes a, b, c, &c.

THE universality of the preceding demonstrations is no way affected by our having always supposed m equal to some particular number, because the reasoning is the same, whatever value be assigned to it.

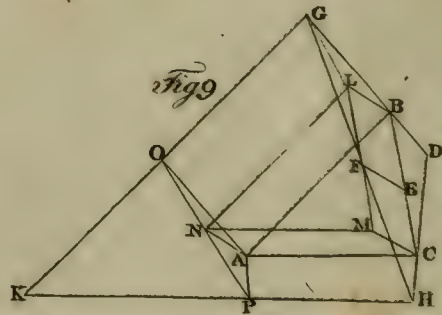
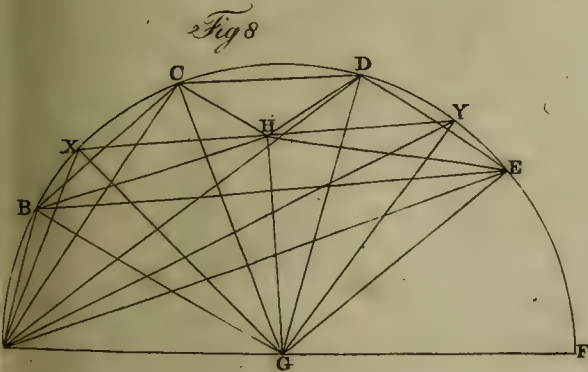
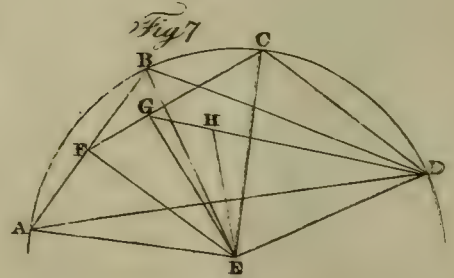
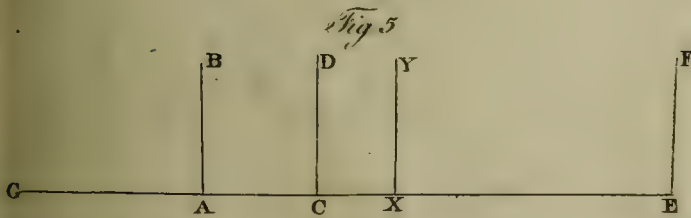
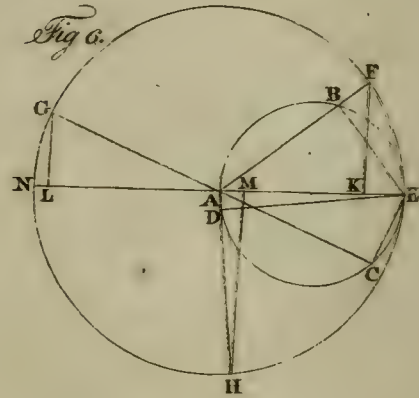
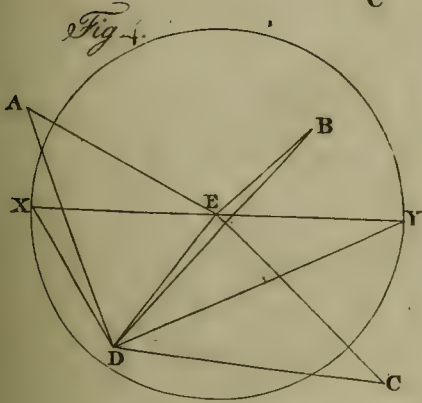
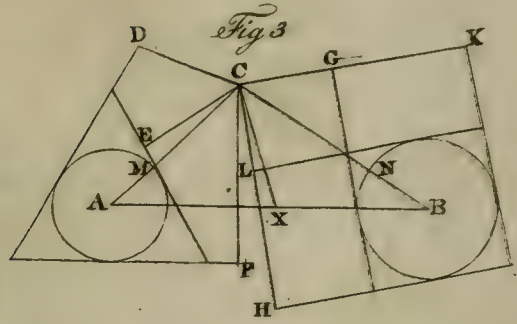
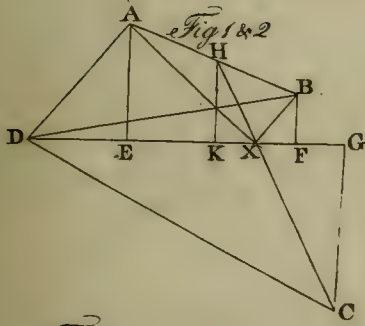




Fig. 10. N. 1.

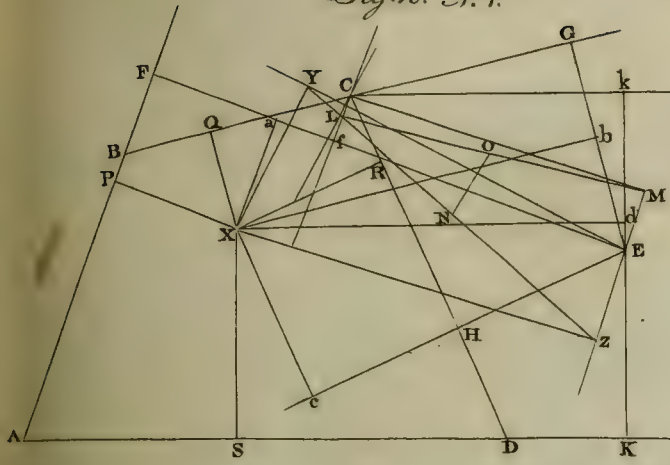


Fig. 10. N. 2.

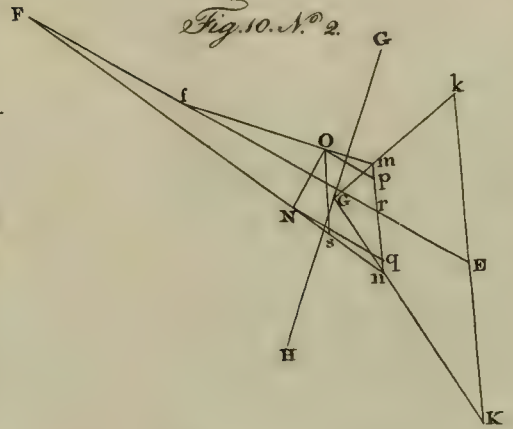


Fig. 12

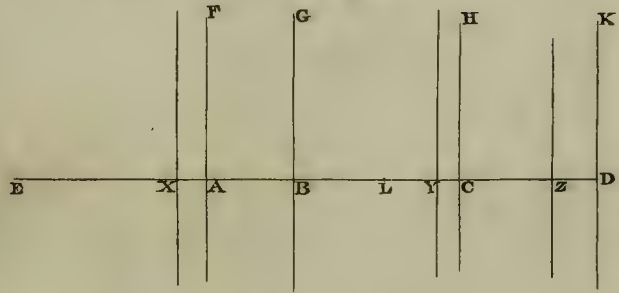


Fig. 11

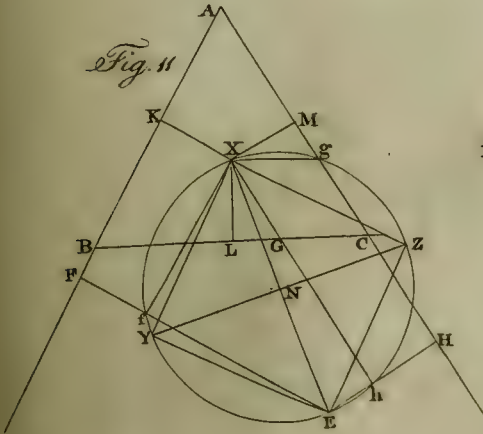


Fig. 13.

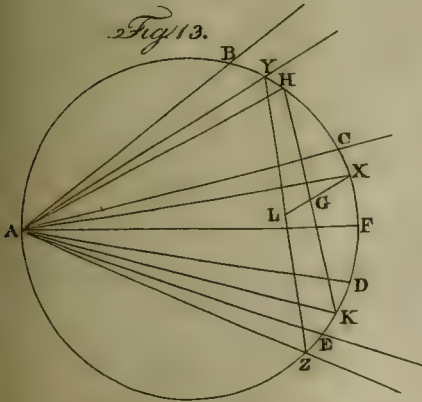


Fig. 14. N. 1.

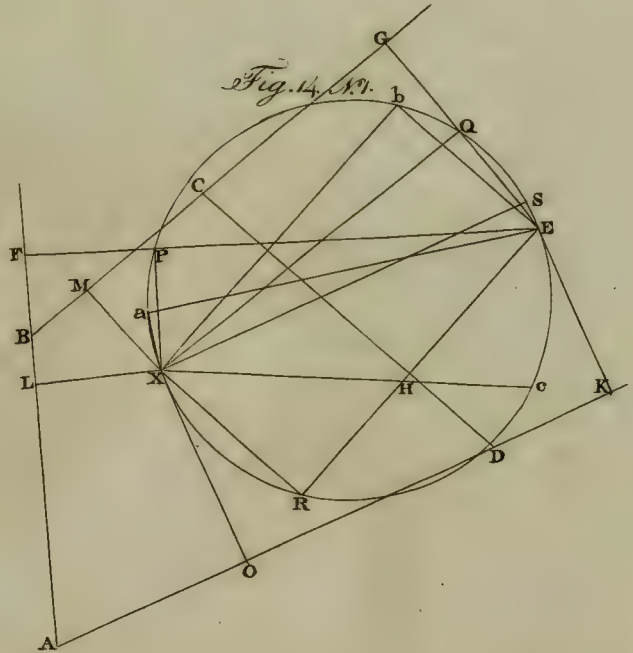




Fig. 14. 1. 2

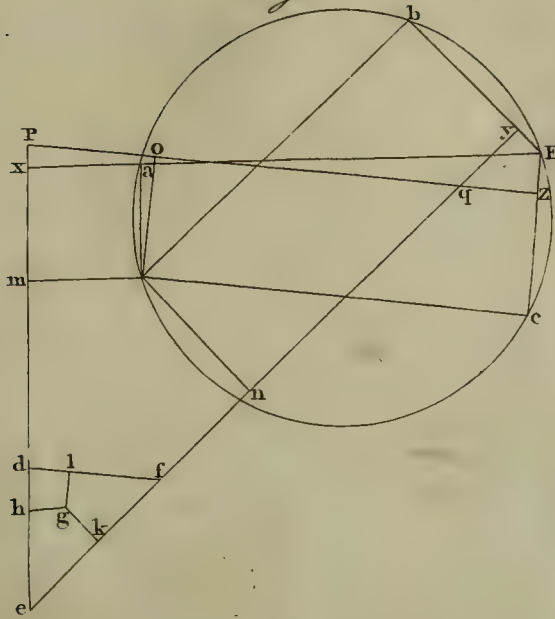
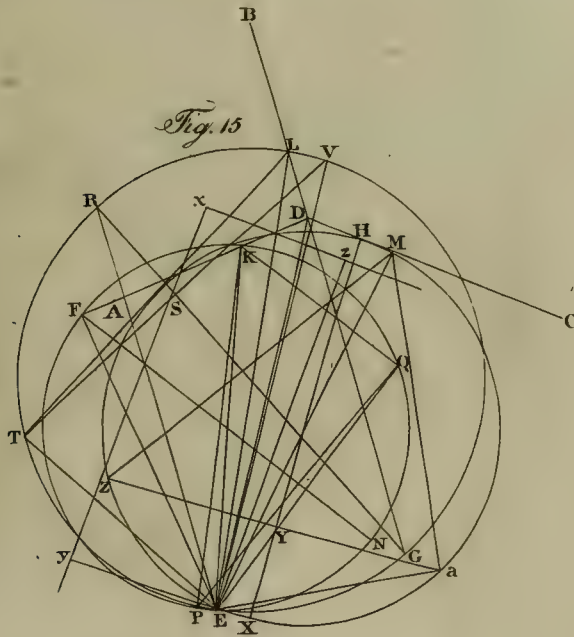


Fig. 15





XIII. REMARKS *on the ASTRONOMY of the BRAHMINS.*

*By JOHN PLATFAIR, A.M. F.R.S. EDIN. and
Professor of Mathematics in the University of Edinburgh.*

[*Read by the Author, March 2. 1789.*]

1. **S**INCE the time when Astronomy emerged from the obscurity of ancient fable, nothing is better known than its progress through the different nations of the earth. With the era of NABONASSAR, regular observations began to be made in Chaldea; the earliest which have merited the attention of succeeding ages. The curiosity of the Greeks was, soon after, directed to the same object; and that ingenious people was the first that endeavoured to explain, or connect by theory, the various phenomena of the heavens. This work was supposed to be so fully accomplished in the Syntaxis of PROLEMY, that his system, without opposition or improvement, continued, for more than five hundred years, to direct the Astronomers of Egypt, Italy and Greece. After the sciences were banished from Alexandria, his writings made their way into the east, where, under the Caliphs of Bagdat, Astronomy was cultivated with diligence and success. The Persian Princes followed the example of those of Bagdat, borrowing besides, from Trebisond, whatever mathematical knowledge was still preserved among the ruins of the Grecian empire. The conquests of GENGIS, and afterwards of TIMOUR, though they retarded, did not stop the progress of Astronomy in the east. The grandsons of these two conquerors were equally renowned for
their

their love of science: HULAGU restored Astronomy in Persia, and ULUGH-BEIGH, by an effort still more singular, established it in Tartary. In the mean time, having passed with the Arabs into Spain, it likewise found, in ALPHONSO of Castile, both a disciple and a patron. It was carried, soon after, into the north of Europe, where, after exercising the genius of COPERNICUS, of KEPLER, and of NEWTON, it has become the most perfect of all the sciences.

2. IN the progress which Astronomy has thus made, through almost all the nations, from the Indus to the Atlantic, there is scarce a step which cannot be accurately traced; and it is never difficult to determine what each age, or nation received from another, or what it added to the general stock of astronomical knowledge. The various systems, that have prevailed in all these countries, are visibly connected with one another; they are all derived from one original, and would incline us to believe, that the manner in which men begin to observe the heavens, and to reason about them, is an experiment on the human race, which has been made but once.

It is, therefore, matter of extreme curiosity to find, beyond the Indus, a system of astronomical knowledge that appears to make no part of the great body of science, which has traversed, and enlightened the other countries of the earth; a system that is in the hands of men, who follow its rules without understanding its principles, and who can give no account of its origin, except that it lays claim to an antiquity far beyond the period, to which, with us, the history of the heroic ages is supposed to extend.

3. WE owe our first knowledge of this astronomy to M. LA LOUBERE, who, returning, in 1687, from an embassy to Siam, brought with him an extract from a Siamese manuscript, which contained tables, and rules, for calculating the places of the sun and moon *. The manner in which these rules were laid
down

* Mem. de l'Acad. des Sciences, tom. 8. p. 281. &c.

down, rendered the principles, on which they were founded, extremely obscure ; and it required a commentator, as conversant with astronomical calculation as the celebrated CASSINI, to explain the meaning of this curious fragment. After that period, two other sets of astronomical tables were sent to Paris, by the missionaries in HINDOSTAN ; but they remained unnoticed, till the return of M. LE GENTIL from India, where he had been to observe the transit of Venus in 1769. This Academician employed himself, during the long stay, which his zeal for science induced him to make in that country, in acquiring a knowledge of the Indian astronomy. The Brahmins thought they saw, in the business of an Astronomer, the marks of a *Cass*, that had some affinity to their own, and began to converse with M. LE GENTIL, more familiarly than with other strangers. A learned Brahmin of Tirvalore, having made a visit to the French Astronomer, instructed him in the methods, which he used for calculating eclipses of the sun and moon, and communicated to him the tables and rules, that are published in the Memoirs of the Academy of Sciences, for 1772. Since that time, the ingenious and eloquent author of the History of Astronomy, has dedicated an entire volume to the explanation, and comparison of these different tables, where he has deduced, from them, many interesting conclusions *. The subject indeed merited his attention ; for the Indian astronomy has all the precision necessary for resolving the great questions, with respect to its own origin and antiquity, and is by no means among the number of those imperfect fragments of ancient knowledge, which can lead no farther than conjecture, and which an Astronomer would gladly resign to the learned researches of the Antiquary, or the Mythologist.

4. It is from these sources, and chiefly from the elaborate investigations of the last mentioned work, that I have selected

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the

* *Traité de l'Astronomie Indienne et Orientale*, par M. BAILLY. Paris, 1787.

the materials of the paper, which I have now the honour to lay before this Society ; and it is perhaps necessary that I should make some apology for presenting here, what can have so little claim to originality. The fact is, that notwithstanding the most profound respect, for the learning and abilities of the author of the *Astronomie Indienne*, I entered on the study of that work, not without a portion of the scepticism, which whatever is new and extraordinary in science ought always to excite, and set about verifying the calculations, and examining the reasonings in it, with the most scrupulous attention. The result was, an entire conviction of the accuracy of the one, and of the solidity of the other ; and I then fancied, that, in an argument of such variety, I might perhaps do a service to others, by presenting to them, that particular view of it, which had appeared to me the most striking. Such, therefore, is the object of these remarks ; they are directed to three different points : The first is to give a short account of the Indian astronomy, so far as it is known to us, from the four sets of tables above mentioned ; the second, to state the principal arguments, that can be deduced from these tables, with respect to their antiquity ; and the third, to form some estimate of the geometrical skill, with which this astronomical system is constructed. In the first, I have followed M. BAILLY closely ; in the second, though I have sometimes taken a different road, I have always come to the same conclusion ; having aimed at nothing so much, as to reduce the reasoning into a narrow compass, and to avoid every argument that is not purely astronomical, and independent of all hypothesis ; in the third, I have treated of a question which did not fall within the plan of M. BAILLY's work, but have only entered on it at present, leaving to some future opportunity, the other discussions to which it leads.

5. THE astronomy of India, as you already perceive, is confined to one branch of the science. It gives no theory, nor even any description of the celestial phenomena, but satisfies
itself

itself with the calculation of certain changes in the heavens, particularly of the eclipses of the sun and moon, and with the rules and tables by which these calculations must be performed. The Brahmin, seating himself on the ground, and arranging his shells before him, repeats the enigmatical verses that are to guide his calculation, and from his little tablets of palm leaves, takes out the numbers that are to be employed in it. He obtains his result with wonderful certainty and expedition; but having little knowledge of the principles on which his rules are founded, and no anxiety to be better informed, he is perfectly satisfied, if, as it usually happens, the commencement and duration of the eclipse answer, within a few minutes, to his prediction. Beyond this his astronomical enquiries never extend; and his observations, when he makes any, go no farther than to determine the meridian line, or the length of the day, at the place where he observes.

THE objects, therefore, which this astronomy presents to us, are principally three. 1. Tables and rules for calculating the places of the sun and moon: 2. Tables and rules for calculating the places of the planets: 3. Rules by which the phases of eclipses are determined. Though it is chiefly to the first of these that our attention at present is to be directed, the two last will also furnish us with some useful observations.

6. THE Brahmins, like all other Astronomers, have distinguished from the rest of the heavens, that portion of them, through which the sun, moon and planets continually circulate. They divide this space, which we call the zodiac, into twenty-seven equal parts, each marked by a group of stars, or a constellation*. This division of the zodiac is extremely natural in the infancy of astronomical observation; because the moon completes her circle among the fixed stars, nearly in twenty-seven days, and so makes an actual division of that circle

into

* Mem. sur l'Astronomie des Indiens, par M. LE GENTIL, Hist. de l'Acad. des Scien. 1772, II. P. 207. The phrase which we here translate *constellations*, signifies the places of the moon in the twelve signs.

into twenty-seven equal parts. The moon too, it must be remembered, was, at that time, the only instrument, if we may say so, by which the positions of the stars on each side of her path could be ascertained; and when her own irregularities were unknown, she was, by the rapidity of her motion eastward, well adapted for this purpose. It is also to the phases of the moon, that we are to ascribe the common division of time into weeks, or portions of seven days, which seems to have prevailed almost over the whole earth*. The days of the week are dedicated by the Brahmins, as by us, to the seven planets, and what is truly singular, they are arranged precisely in the same order.

7. WITH the constellations, that distinguish the twenty-seven equal spaces, into which their zodiac is divided, the Astronomers of India have connected none of those figures of animals, which are among us, of so ancient, and yet so arbitrary an original. M. LE GENTIL has given us their names, and configurations†. They are formed, for the most part, of small groups of stars, such as the Pleiades or the Hyades, those belonging to the same constellation being all connected by straight lines. The first of them, or that which is placed at the beginning of their zodiac, consists of six stars, extending from the head of Aries to the foot of Andromeda, in our zodiac, and occupying a space of about ten degrees in longitude. These constellations are far from including all the stars in the zodiac. M. LE GENTIL remarks, that those stars seem to have been selected, which are best adapted for marking out, by lines drawn between them, the places of the moon in her progress through the heavens.

AT the same time that the stars in the zodiac are thus arranged into twenty-seven constellations, the ecliptic is divided, as with us, into twelve signs of thirty degrees each. This division

* Mem. Acad. des Scien. 1772. II. P. 189.

† Ibid. 209.

vision is purely ideal, and is intended merely for the purpose of calculation. The names and emblems by which these signs are expressed, are nearly the same as with us *; and as there is nothing in the nature of things to have determined this coincidence, it must, like the arrangement of the days of the week, be the result of some ancient and unknown communication.

8. THAT motion by which the fixed stars all appear to move eastward, and continually to increase their distance from the place, that the sun occupies at the vernal equinox, is known to the Brahmins, and enters into the composition of all their tables †. They compute this motion to be at the rate of $54''$ a-year; so that their *annus magnus*, or the time in which the fixed stars complete an entire revolution, is 24,000 years. This motion is too quick by somewhat less than $4''$ a-year; an error that will not be thought great, when it is considered, that PROLEMY committed one of $14''$, in determining the same quantity.

ANOTHER circumstance, which is common to all the tables, and, at the same time, peculiar to the Indian astronomy, is, that they express the longitude of the sun and moon, by their distance from the beginning of the moveable zodiac, and not, as is usual with us, by their distance from the point of the vernal equinox. The longitude is reckoned in signs of 30° , as already mentioned, and each degree is subdivided into $60'$, &c. In the division of time, their arithmetic is purely sexagesimal: They divide the day into 60 hours, the hour into 60 minutes, &c.; so that their hour is 24 of our minutes, their minute 24 of our seconds, and so on.

9. THESE

* Mem. Acad. des Scien. 1772. II. P. 200. The zodiac they call *fodi-mandalam*, or the circle of stars.

† Ibid. 194. Aft. Indienne, p. 43, &c.

9. THESE remarks refer equally to all the tables. We are now to take notice of what is peculiar to each, beginning with those of Siam.

IN order to calculate for a given time, the place of any of the celestial bodies, three things are requisite. The first is, the position of the body in some past instant of time, ascertained by observation; and this instant, from which every calculation must set out, is usually called the *epoch* of the tables. The second requisite is, the mean rate of the planet's motion, by which is computed the arch in the heavens, that it must have described, in the interval between the epoch and the instant for which the calculation is made. By the addition of this, to the place at the epoch, we find the mean place of the planet, or the point it would have occupied in the heavens, had its motion been subject to no irregularity. The third is, the correction, on account of such irregularity, which must be added to the mean place, or subtracted from it, as circumstances require, in order to have the true place. The correction thus made is, in the language of astronomy, called an *equation*; and, when it arises from the eccentricity of a planet's orbit, it is called the *equation of the centre*.

10. THE epoch of the tables of Siam does not go back to any very remote period. M. CASSINI, by an ingenious analysis of their rules, finds that it corresponds to the 21st of March, in the year 638 of our era, at 3 in the morning, on the meridian of Siam*. This was the instant at which the astronomical year began, and at which both the sun and moon entered the moveable zodiac. Indeed, it is to be observed, that, in all the tables, the astronomical year begins when the sun enters the moveable zodiac, so that the beginning of this year is continually advancing with respect to the seasons, and makes the complete round of them in 24,000 years.

FROM

* Mem. Acad. Scien. tom. 8. p. 312. Ast. Indienne, p. 11. § 14.

FROM the epoch above mentioned, the mean place of the sun for any other time is deduced, on the supposition that in 800 years, there are contained 292,207 days*. This supposition involves in it the length of the syderal year, or the time that the sun takes to return to the beginning of the moveable zodiac, and makes it consist of 365 *d.* 6 *b.* 12', 36" †. From this, in order to find the tropical year, or that which regulates the seasons, we must take away 21', 55", as the time which the sun takes to move over the 54", that the stars are supposed to have advanced in the year; there will remain 365 *d.* 5 *b.* 50', 41", which is the length of the tropical year that is involved, not only in the tables of Siam, but likewise, very nearly, in all the rest ‡. This determination of the length of the year is but 1', 53", greater than that of DE LA CAILLE, which is a degree of accuracy beyond what is to be found in the more ancient tables of our astronomy.

II. THE next thing with which these tables present us, is a correction of the sun's mean place, which corresponds to what we call the equation of his centre, or the inequality arising from the eccentricity of his orbit, in consequence of which, he is alternately retarded and accelerated, his true place being, for one half of the year, left behind the mean, and, for the other, advanced before it. The point where the sun is placed, when his motion is slowest, we call his apogee, because his distance from the earth is then greatest; but the Indian astronomy, which is silent with respect to theory, treats this point as nothing more than what it appears to be, a point, *viz.* in the heavens, where the sun's motion is the slowest possible, and about 90° distant from that, where his greatest inequality takes place. This greatest inequality is here made to be

* Aft. Ind. p. 7. § 6.

† Mem. Acad. Scien. tom. 8. p. 328.

‡ Aft. Ind. p. 124. The tables of Tirvalore make the year 6" less.

be 2° , $12'$ *, about $16'$ greater than it is determined, by the modern astronomy of Europe. This difference is very considerable; but we shall find that it is not to be ascribed wholly to error, and that there was a time when the inequality in question was nearly of the magnitude here assigned to it. In the other points of the sun's path, this inequality is diminished, in proportion to the sine of the mean distance from the apogee, that is, nearly as in our own tables. The apogee is supposed to be 80° advanced beyond the beginning of the zodiac, and to retain always the same position among the fixed stars, or to move forward at the same rate with them†. Though this supposition is not accurate, as the apogee gains upon the stars about $10''$ annually, it is much nearer the truth than the system of PTOLEMY, where the sun's apogee is supposed absolutely at rest, so as continually to fall back among the fixed stars, by the whole quantity of the precession of the equinoxes‡.

12. IN these tables, the motions of the moon are deduced, by certain intercalations, from a period of nineteen years, in which she makes nearly 235 revolutions; and it is curious to find at Siam, the knowledge of that cycle, of which the invention was thought to do so much honour to the Athenian Astronomer METON, and which makes so great a figure in our modern

* THE equation of the sun, or what they call the *chaiaa*, is calculated in the Siamese tables only for every 15° of the *matteiomme*, or mean anomaly. CASSINI, *ubi supra*, p. 299.

† Aft. Ind. p. 9.

‡ THE error, however, with respect to the apogee, is less than it appears to be; for the motion of the Indian zodiac, being nearly $4''$ swifter than the stars, is but $6''$ slower than the apogee. The velocity of the Indian zodiac is indeed neither the same with that of the stars, nor of the sun's apogee, but nearly a mean between them.

modern kalendars *. The moon's apogee is supposed to have been in the beginning of the moveable zodiac, 621 days after the epoch of the 21st of March 638, and to make an entire revolution in the heavens in the space of 3232 days †. The first of these suppositions agrees with MAYER's tables to less than a degree, and the second differs from them only by 11^b , $14'$, $31''$; and if it be considered that the apogee is an ideal point in the heavens, which even the eyes of an astronomer cannot directly perceive, to have discovered its true motion, so nearly, argues no small correctness of observation.

13. FROM the place of the apogee, thus found, the inequalities of the moon's motion, which are to reduce her mean to her true place, are next to be determined. Now, at the oppositions and conjunctions, the two greatest of the moon's inequalities, the equation of the centre and the evection, both depend on the distance from the apogee, and therefore appear but as one inequality. They also, partly, destroy one another; so that the moon is retarded or accelerated, only by their difference, which, when greatest, is, according to MAYER's tables, 4° , $57'$, $42''$. The Siamese rules, which calculate only for oppositions and conjunctions, give, accordingly, but one inequality to the moon, and make it, when greatest, 4° , $56'$, not $2'$ less than the preceding. This greatest equation is applied, when the moon's mean distance from the apogee is 90° ; in other situations, the equation is less, in proportion as the sine of that distance diminishes ‡.

14. THE Siamese MS. breaks off here, and does not inform us how the astronomers of that country proceed, in the remaining parts of their calculation, which they seem to have under-

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taken,

* THE Indian period is more exact than that of our golden number, by $35'$. Ast. Ind. p. 5. The Indians regulate their festivals by this period. *Ibid.* Disc. Prelim. p. viii.

† Ast. Ind. p. 11. & 20.

‡ Ast. Indienne, p. 13. CASSINI Mem. Acad. tom. 8. p. 304.

undertaken, merely for some purpose in astrology. M. CASSINI, to whom we are indebted for the explanation of these tables, observes, that they are not originally constructed for the meridian of Siam, because the rules direct to take away $3'$ for the sun, and $40'$ for the moon, (being the motion of each for 1^h , $13'$), from their longitudes calculated as above*. The meridian of the tables is therefore 1^h , $13'$, or 18° , $15'$, west of Siam; and it is remarkable, that this brings us very near to the meridian of Benares, the ancient seat of Indian learning†. The same agrees nearly with what the Hindoos call their first meridian, which passes through Ceylon and the Banks of Ramanancor. We are, therefore, authorised, or rather, we are necessarily determined to conclude, that the tables of Siam came originally from HINDOSTAN.

15. ANOTHER set of astronomical tables, now in the possession of the Academy of Sciences, was sent to the late M. DE L'ISLE from Chirsnabouram, a town in the Carnatic, by Father DU CHAMP, about the year 1750. Though these tables have an obvious affinity to what have already been described, they form a much more regular and extensive system of astronomical knowledge. They are fifteen in number; and include, beside the mean motions of the sun, moon and planets, the equations to the centre of the sun and moon, and two corrections for each of the planets, the one of which corresponds to its apparent, and the other to its real inequality. They are accompanied also with precepts, and examples, which Father DU CHAMP received from the Brahmins of Chirsnabouram, and which he has translated into French‡.

THE

* Mem. Acad. Scien. tom. 8. p. 302. & 309.

† Ast. Ind. p. 12. It brings us to a meridian 82° , $34'$, east of Greenwich. Benares is 83° , $11'$, east of the same, by RENNEL's map.

‡ These tables are published by M. BAILLY, Ast. Ind. p. 335, &c. See also p. 31, &c.

THE epoch of these tables is less ancient than that of the former, and answers to the 10th of March at sunrise, in the year 1491 of our era, when the sun was just entering the moveable zodiac, and was in conjunction with the moon; two circumstances, by which almost all the Indian eras are distinguished. The places, which they assign, at that time, to the sun and moon, agree very well with the calculations made from the tables of *MAYER*, and *DE LA CAILLE*. In their mean motions, they indeed differ somewhat from them; but as they do so equally for the sun and moon, they produce no error, in determining the relative position of these bodies, nor, of consequence, in calculating the phenomena of eclipses. The sun's apogee is here supposed to have a motion swifter than that of the fixed stars, by about 1" in nine years, which, though it falls greatly short of the truth, does credit to this astronomy, and is a strong mark of originality. The equation of the sun's centre is somewhat less here than in the tables of Siam; it is $2^{\circ}, 10', 30''$; the equation of the moon's centre is $5^{\circ}, 2', 47''$; her path, where it intersects that of the sun, is supposed to make an angle with it of $4^{\circ}, 30'$, and the motions, both of the apogee and node, are determined very near to the truth.

16. ANOTHER set of tables, sent from India by Father *PATOUILLET*, were received by *M. DE L'ISLE*, about the same time with those of *Chrisnabouram*. They have not the name of any particular place affixed to them; but, as they contain a rule for determining the length of the day, which answers to the latitude of $16^{\circ}, 16'$, *M. BAILLY* thinks it probable that they come from *Narfapour* *.

THE precepts and examples, which accompany these tables, though without any immediate reference to them, are confined to the calculation of the eclipses of the sun and moon; but the tables themselves extend to the motion of the planets, and very much resemble those of *Chrisnabouram*, except that they are given with less detail, and in a form much

* *Ast. Ind.* p. 49, &c.

more enigmatical *. The epoch of the precepts, which M. BAILLY has evolved with great ingenuity, goes back no farther than the year 1569, at midnight, between the 17th and 18th of March. From this epoch, the places of the sun and moon are computed, as in the tables of Siam, with the addition of an equation, which is indeed extremely singular. It resembles that correction of the moon's motion, which was discovered by TYCHO, and which is called the annual equation, because its quantity depends, not on the place of the moon, but on the place of the sun, in the ecliptic. It is every where proportional to the inequality of the sun's motion, and is nearly a tenth part of it. The tables of Narâpouur make their annual equation only $\frac{1}{27}$ of the sun's: but this is not their only mistake; for they direct the equation to be added to the moon's longitude, when it ought to be subtracted from it, and *vice versa*. Now, it is difficult to conceive from whence the last mentioned error has arisen; for though it is not at all extraordinary, that the astronomers, who constructed these tables, should mistake the quantity of a small equation, yet it is impossible, that the same observations, which informed them of its existence, should not have determined, whether it was to be added or subtracted. It would seem, therefore, that something accidental must have occasioned this error; but however that be, an inequality in the lunar motions, that is found in no system with which the astronomers of India can have had any communication, is at least a proof of the originality of their tables.

17. THE tables, and methods, of the Brahmins of Tirvalore, are, in many respects, more singular than any that have yet been

* THEY were explained, or rather decyphered by M. LE GENTIL in the Memoirs of the Academy of Sciences for 1784, p. 482, &c.; for they were not understood by the missionary who sent them to Europe, nor probably by the Brahmins who instructed him. M. LE GENTIL thinks that they have the appearance of being copied from inscriptions on stone. The minutes and seconds are ranged in rows under one another, not in vertical columns, and without any title to point out their meaning, or their connection. These tables are published, Mem. Acad. *ibid.* p. 492, and Ast. Ind. p. 414.

been described *. The solar year is divided, according to them, into twelve unequal months, each of which is the time that the sun takes to move through one sign, or 30° , of the ecliptic. Thus, *Any*, or June, when the sun is in the third sign, and his motion slowest, consists of 31^d , 36^h , $38'$, and *Margagy*, or December, when he is in the ninth sign, and his motion quickest, consists only of 29^d , 20^h , $53'$ †. The lengths of these months, expressed in natural days, are contained in a table, which, therefore, involves in it the place of the sun's apogee, and the equation of his centre. The former seems to be 77° from the beginning of the zodiac, and the latter about 2° , $10'$, nearly as in the preceding tables. In their calculations, they also employ an astronomical day, which is different from the natural, being the time that the sun takes to move over one degree of the ecliptic; and of which days there are just 360 in a year ‡.

18. THESE tables go far back into antiquity. Their epoch coincides with the famous era of the Calyougham, that is, with the beginning of the year 3102 before CHRIST. When the Brahmins of Tirvalore would calculate the place of the sun for a given time, they begin by reducing into days the interval between that time, and the commencement of the Calyougham, multiplying the years by 365^d , 6^h , $12'$, $30''$; and taking away 2^d , 3^h , $32'$, $30''$, the astronomical epoch having begun that much later than the civil ||. They next find, by means of certain divisions, when the year current began,

* TIRVALORE is a small town on the Coromandel coast, about 12 G. miles west of Negapatnam, in Lat. 10° , $44'$, and east Long. from Greenwich, 79° , $42'$, by RENNEL's map. From the observations of the Brahmins, M. LE GENTIL makes its Lat. to be 10° , $42'$, $13''$. (Mem. Acad. Scien. II. P. 184.) The meridian of Tirvalore nearly touches the west side of Ceylon, and therefore may be supposed to coincide with the first meridian, as laid down by Father DU CHAMP. There is no reduction of Longitude employed in the methods of Tirvalore.

† These are Indian hours, &c.

‡ Mem. Acad. des Scien. II. P. 187. Ast. Indienne, p. 76, &c.

|| The Indian hours are here reduced to European.

gan, or how many days have elapsed since the beginning of it, and then, by the table of the duration of months, they reduce these days into astronomical months, days, &c. which is the same with the signs, degrees and minutes of the sun's longitude from the beginning of the zodiac. The sun's longitude, therefore, is found.

19. SOMEWHAT in the same manner, but by a rule still more artificial and ingenious, they deduce the place of the moon, at any given time, from her place at the beginning of the Calyougham *. This rule is so contrived, as to include at once the motions both of the moon and of her apogee, and depends on this principle, according to the very skilful interpretation of M. BAILLY, that, 1,600,894 days after the above mentioned epoch, the moon was in her apogee, and $7^{\circ}, 2', 0'', 7''$, distant from the beginning of the zodiac; that after 12,372 days, the moon was again in her apogee, with her longitude increased, $9^{\circ}, 27', 48', 10''$; that in 3031 days more, the moon is again in her apogee, with $11^{\circ}, 7', 31', 1''$, more of longitude; and, lastly, that, after 248 days, she is again in her apogee, with $27^{\circ}, 44', 6''$, more of longitude. By means of the three former numbers, they find, how far, at any given time, the moon is advanced in this period of 248 days, and by a table, expressing how long the moon takes to pass through each degree of her orbit, during that period, they find how far she is then advanced in the zodiac †. This rule is strongly marked with all the peculiar characters of the Indian astronomy: It is remarkable for its accuracy, and still more for its ingenuity and refinement; but is not reduced withal, to its ultimate simplicity.

20. THE tables of Tirvalore, however, though they differ in form very much from those formerly described, agree with them

* Mem. Acad. des Scien. *ibid.* p. 229. Ast. Ind. p. 84.

† M. LE GENTIL has given this table, Mem. Acad. *ibid.* p. 261.

them perfectly in many of their elements. They suppose the same length of the year, the same mean motions, and the same inequalities of the sun and moon, and they are adapted nearly to the same meridian*. But a circumstance in which they seem to differ materially from the rest is, the antiquity of the epoch from which they take their date, the year 3102 before the Christian era. We must, therefore, enquire, whether this epoch is real or fictitious, that is, whether it has been determined by actual observation, or has been calculated from the modern epochs of the other tables. For it may naturally be supposed, that the Brahmins, having made observations in later times, or having borrowed from the astronomical knowledge of other nations, have imagined to themselves a fictitious epoch, coinciding with the celebrated era of the Calyougham, to which, through

* THE accuracy of the geography of the Hindoos, is in no proportion to that of their astronomy, and, therefore, it is impossible that the identity of the meridians of their tables can be fully established. All that can be said, with certainty, is, that the difference between the meridians of the tables of Tirvalore and Siam is, at most, but inconsiderable, and may be only apparent, arising from an error in computing the difference of longitude between these places. The tables of Tirvalore are for Long. 79° , $42'$; those of Siam for 82° , $34'$; the difference is 2° , $52'$, not more than may be ascribed to an error purely geographical.

As to the tables of Chrisnabouram, they contain a reduction, by which it appears, that the place where they are now used is $45'$ of a degree east of the meridian for which they were originally constructed. This makes the latter meridian agree tolerably with that of Cape Comorin, which is in Long. 77° , $32'$, $30''$, and about half a degree west of Chrisnabouram. But this conclusion is uncertain; because, as M. BAILLY has remarked, the tables sent from Chrisnabouram, and understood by Father du CHAMP to belong to that place, are not adapted to the latitude of it, but to one considerably greater, as appears from their rule for ascertaining the length of the day. (*Ast. Ind.* p. 33.)

THE characters, too, by which the Brahmins distinguish their first meridian, are not perfectly consistent with one another. Sometimes it is described as bisecting Ceylon; and at other times, as touching it on the west side, or even as being as far west as Cape Comorin. Lanka, which is said to be a point in it, is understood, by Fath. du CHAMP, to be Ceylon. M. BAILLY thinks that it is the lake Lanka, the source of the Gogra, placed by M. RENNEL, as well as the middle of Ceylon, in Long. 80° , $42'$; but, from a Hindoo map, in the *Ayeen Akbery*, vol. iii. p. 25. Lanka appears to be an island which marks the intersection of the first meridian of the map, nearly that of Cape Comorin, with the equator; and is probably one of the Maldivy islands. See also a note in the *Ayeen Akbery*, *ibid.* p. 36.

through vanity or superstition, they have referred the places of the heavenly bodies, and have only calculated what they pretend that their ancestors observed.

21. IN doing this, however, the Brahmins must have furnished us with means, almost infallible, of detecting their imposture. It is only for astronomy, in its most perfect state, to go back to the distance of forty-six centuries, and to ascertain the situation of the heavenly bodies at so remote a period. The modern astronomy of Europe, with all the accuracy that it derives from the telescope and the pendulum, could not venture on so difficult a task, were it not assisted by the theory of gravitation, and had not the integral calculus, after an hundred years of almost continual improvement, been able, at last, to determine the disturbances in our system, which arise from the action of the planets on one another.

UNLESS the corrections for these disturbances be taken into account, any system of astronomical tables, however accurate at the time of its formation, and however diligently copied from the heavens, will be found less exact for every instant, either before or after that time, and will continually diverge more and more from the truth, both for future and past ages. Indeed, this will happen, not only from the neglect of these corrections, but also from the small errors unavoidably committed, in determining the mean motions, which must accumulate with the time, and produce an effect that becomes every day more sensible, as we retire, on either side, from the instant of observation. For both these reasons, it may be established as a maxim, that, if there be given a system of astronomical tables, founded on observations of an unknown date, that date may be found, by taking the time when the tables represent the celestial motions most exactly.

HERE, therefore, we have a criterion, by which we are to judge of the pretensions of the Indian astronomy to so great antiquity. It is true, that, in applying it, we must suppose our
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modern astronomy, if not perfectly accurate, at least so exact as to represent the celestial motions, without any sensible error, even for a period more remote than the Calyougham; and this, considering the multitude of observations on which our astronomy is founded, the great antiquity of some of those observations, and the extreme accuracy of the rest, together with the assistance derived from the theory of physical causes, may surely be assumed as a very reasonable postulatum. We begin with the examination of the mean motions.

22. THE Brahmins place the beginning of their moveable zodiac, at the time of their epoch, 54° before the vernal equinox, or in the longitude of $10^{\circ}, 6'$, according to our method of reckoning. Now, M. LE GENTIL brought with him a delineation of the Indian zodiac, from which the places of the stars in it may be ascertained with tolerable exactness*. In particular, it appears, that Aldebaran, or the first star of Taurus, is placed in the last degree of the fourth constellation, or $53^{\circ}, 20'$, distant from the beginning of the zodiac. Aldebaran was therefore $40'$ before the point of the vernal equinox, according to the Indian astronomy, in the year 3102 before CHRIST. But the same star, by the best modern observations, was, in the year 1750, in longitude, $2^{\circ}, 6', 17', 47''$; and had it gone forward, according to the present rate of the precession of the equinoxes, $50''\frac{1}{2}$ annually, it must have been, at the era of the Calyougham, $1^{\circ}, 32'$, before the equinox. But this result is to be corrected, in consequence of the inequality in the precession, discovered by M. DE LA GRANGE†, by the addition of $1^{\circ}, 45', 22''$, to the longitude of Aldebaran, which gives the longitude of that star $13'$ from the vernal equinox, at the time of the Calyougham, agreeing, within $53'$, with the determination of the Indian astronomy‡.

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* Mem. Acad. Scien. 1772, II. P. 214. Ast. Ind. p. 129.

† Mem. Acad. de Berlin, 1782, p. 287. Ast. Ind. p. 144.

‡ Ast. Ind. p. 130.

THIS agreement is the more remarkable, that the Brahmins, by their own rules for computing the motion of the fixed stars, could not have assigned this place to Aldebaran for the beginning of the Calyougham, had they calculated it from a modern observation. For as they make the motion of the fixed stars too great by more than 3" annually, if they had calculated backward from 1491, they would have placed the fixed stars less advanced by 4° or 5° , at their ancient epoch, than they have actually done. This argument carries with it a great deal of force; and even were it the only one we had to produce, it would render it, in a high degree, probable, that the Indian zodiac was as old as the Calyougham.

23. LET us next compare the places of the sun and moon, for the beginning of the Calyougham, as deduced from the Indian and the modern astronomy. And, first, of the sun, though, for a reason that will immediately appear, it is not to be considered as leading to any thing conclusive. M. BAILLY, from a comparison of the tables of Tirvalore with those of Chirfnabouram, has determined the epoch of the former to answer to midnight, between the 17th and 18th* of February of the year 3102 before CHRIST, at which time the sun was just entering the moveable zodiac, and was therefore in longitude 10° , 6° . M. BAILLY also thinks it reasonable to suppose, that this was not the mean place of the sun, as the nature of astronomical tables require, but the true place, differing from the mean, by the equation to the sun's centre at that time†. This, it must be confessed, is the mark of greatest unskilfulness, that we meet with in the construction of these tables. Supposing it, however, to be the case, the mean place of the sun, at the time
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* Aft. Ind. p. 110. The Brahmins, however, actually suppose the epoch to be 6 hours later, or at sunrise, on the same day. Their mistake is discovered, as has been said, by comparing the radical places in the different tables with one another.

† Aft. Ind. p. 83.

of the epoch, comes out $10^{\circ}, 3', 38'', 13'''$. Now, the mean longitude of the sun, from DE LA CAILLE's tables, for the same time, is $10^{\circ}, 1', 5', 57''$, supposing the precession of the equinoxes to have been uniformly at the rate it is now, that is, $50''\frac{1}{3}$ annually. But M. DE LA GRANGE has demonstrated, that the precession was less in former ages than in the present; and his formula gives $1^{\circ}, 45', 22''$, to be added, on that account, to the sun's longitude already found, which makes it $10^{\circ}, 2^{\circ}, 51', 19''$, not more than $47'$ from the radical place in the tables of Tirvalore. This agreement is near enough to afford a strong proof of the reality of the ancient epoch, if it were not for the difficulty that remains about considering the sun's place as the true, rather than the mean; and, for that reason, I am unwilling that any stress should be laid upon this argument. The place of the moon is not liable to the same objection.

24. THE moon's mean place, for the beginning of the Calyougham, (that is, for midnight between the 17th and 18th of February 3102, A. C. at Benares), calculated from MAYER's tables, on the supposition that her motion has always been at the same rate as at the beginning of the present century, is $10^{\circ}, 0^{\circ}, 51', 16''$ *. But, according to the same astronomer, the moon is subject to a small, but uniform acceleration, such, that her angular motion, in any one age, is $9''$ greater than in the preceding, which, in an interval of 4801 years, must have amounted to $5^{\circ}, 45', 44''$. This must be added to the preceding, to give the real mean place of the moon, at the astronomical epoch of the Calyougham, which is therefore $10^{\circ}, 6^{\circ}, 37'$. Now, the same, by the tables of Tirvalore, is $10^{\circ}, 6^{\circ}, 0'$; the difference is less than two-thirds of a degree, which, for so remote a period, and considering the acceleration of the moon's motion, for which no allowance

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could

* Ast. Ind. p. 142, &c. The first meridian is supposed to pass through Benares; but even if it be supposed 3° farther west, the difference, which is here $37'$, will be only increased to $42'$.

could be made in an Indian calculation, is a degree of accuracy that nothing but actual observation could have produced.

25. To confirm this conclusion, M. BAILLY computes the place of the moon for the same epoch, by all the tables to which the Indian astronomers can be supposed to have ever had access *. He begins with the tables of PTOLEMY; and if, by help of them, we go back from the era of NABONASSAR, to the epoch of the Calyougham, taking into account the comparative length of the Egyptian and Indian years, together with the difference of meridians between Alexandria and Tirvalore, we shall find the longitude of the sun 10° , $21'$, $15''$ greater, and that of the moon 11° , $52'$, $7''$ greater than has just been found from the Indian tables †. At the same time that this shews, how difficult it is to go back, even for a less period than that of 3000 years, in an astronomical computation, it affords a proof, altogether demonstrative, that the Indian astronomy is not derived from that of PTOLEMY.

THE tables of ULUGH BEIG are more accurate than those of the Egyptian astronomer. They were constructed in a country not far from India, and but a few years earlier than 1491, the epoch of the tables of Chrisnabouram. Their date is July 4. at noon, 1437, at Samarcand; and yet they do not agree with the Indian tables, even at the above mentioned epoch of 1491 ‡. But, for the year 3102 before CHRIST, their difference from them, in the place of the sun, is 1° , $30'$, and in that of the moon 6° ; which, though much less than the former differences, are sufficient to shew, that the tables of India are not borrowed from those of Tartary.

THE Arabians employed in their tables the mean motions of PTOLEMY; the Persians did the same, both in the more ancient tables of CHRYSOCOCCA, and the later ones of NASSIREDDIN ||. It

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* Aft. Ind. p. 114.

† Ibid. p. 115.

‡ Ibid. p. 117.

|| Ibid. p. 118.

is therefore certain, that the astronomy of the Brahmins is neither derived from that of the Greeks, the Arabians, the Persians or the Tartars. This appeared so clear to CASSINI, though he had only examined the tables of Siam; and knew nothing of many of the great points which distinguish the Indian astronomy from that of all other nations, that he gives it as his opinion, that these tables are neither derived from the Persian astronomy of CHRYSOCOCCA, nor from the Greek astronomy of PTOLEMY; the places they give at their epoch to the apogee of the sun, and of the moon, and their equation for the sun's centre, being very different from both*.

26. BUT, to return to what respects the moon's acceleration; it is plain, that tables, as ancient as those of Tirvalore pretend to be, ought to make the mean motion of that planet much slower than it is at present. They do accordingly suppose, in the rule for computing the place of the moon, already described, that her motion for 4383 years, 94 days, reckoned in the moveable zodiac from the epoch of the Calyougham, is $7^{\circ}, 2^{\circ}, 0', 7'',$ or $9^{\circ}, 7^{\circ}, 45', 1'',$ when referred to the fixed point of the vernal equinox. Now, the mean motion for the same interval, taken from the tables of MAYER, is greater than this, by $2^{\circ}, 42', 4''$ †, which, though conformable, in general, to the notion of the moon's motion having been accelerated, falls, it must be confessed, greatly short of the quantity which MAYER has assigned to that acceleration. This, however, is not true of all the tables; for the moon's motion in 4383 years, 94 days, taken from those of Chirsnabouram, is $3^{\circ}, 2', 10''$ less than in the tables of Tirvalore ‡; from which it is reasonable to conclude, with M. BAILLY, that the former are, in reality, more ancient than the latter, though they do not profess to be so: and hence, also, the tables of Chirsnabouram make

* Mem. Acad. Scien. tom. 8. p. 286.

† Aft. Ind. p. 145.

‡ Ibid. p. 126.

make the moon's motion less than MAYER's, for the above mentioned interval, by $5^{\circ}, 44', 14''$, which therefore is, according to them, the quantity of the acceleration.

27. Now, it is worthy of remark, that if the same be computed on MAYER's principles, that is, if we calculate how much the angular motion of the moon for 4383 years, 94 days, dated from the beginning of the Calyougham, must have been less than if her velocity had been all that time uniform, and the same as in the present century, we shall find it to be $5^{\circ}, 43', 7''$, an arch which is only $1', 7''$, less than the former. The tables of Chirfnabouram, therefore, agree with those of MAYER, when corrected by the acceleration within $1', 7''$, and that for a period of more than four thousand years. From this remarkable coincidence, we may conclude, with the highest probability, that at least one set of the observations, on which those tables are founded, is not less ancient than the Calyougham; and though the possibility of their being some ages later than that epoch, is not absolutely excluded, yet it may, by strict mathematical reasoning, be inferred, that they cannot have been later than 2000 years before the Christian era*.

28. THIS

* THE reasoning here referred to is the following: As the mean motions, in all astronomical tables, are determined by the comparison of observations made at a great distance of time from one another; if x be the number of centuries between the beginning of the present, and the date of the more ancient observations, from which the moon's mean motion in the tables of Chirfnabouram is deduced; and if y denote the same for the more modern observations: then the quantity by which the moon's motion, during the interval $x-y$, falls short of MAYER's, for the same interval, is $(x^2-y^2)g'$.

IF, therefore, m be the motion of the moon for a century in the last mentioned tables, $m(x-y)-g'(x^2-y^2)$ will be the mean motion for the interval $x-y$ in the tables of Chirfnabouram. If, then, a be any other interval, as that of 43.83 centuries, the mean motion assigned to it, in these last tables, by the rule of proportion, will be $\frac{m(x-y)-g'(x^2-y^2)}{x-y} = ma - ga(x+y)$. Let this motion, actually taken from the ta-

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28. THIS last is one of the few coincidences between the astronomy of India and of Europe, which their ingenious historian has left for others to observe. Indeed, since he wrote, every argument, founded on the moon's acceleration, has become more worthy of attention, and more conclusive. For that acceleration is no longer a mere empirical equation, introduced to reconcile the ancient observations with the modern, nor a fact that can only be accounted for by hypothetical causes, such as the resistance of the ether, or the time necessary for the transmission of gravity; it is a phenomenon, which M. DE LA PLACE has *, with great ability, deduced from the principle of universal gravitation, and shewn to be necessarily connected with the changes in the eccentricity of the earth's orbit, discovered by M. DE LA GRANGE; so that the acceleration of the moon is indirectly produced by the action of the planets, which alternately increasing and diminishing the said eccentricity, subjects the moon to different degrees of that force by which the sun disturbs the time of her revolution round the earth. It is therefore a periodical inequality, by which the moon's motion, in the course of ages, will be as much retarded as accelerated; but its changes are so slow, that her motion has been constantly accelerated, even for a longer period than that to which the observations of India extend.

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bles be $= na$, then $ma - na = 9a(x+y)$, or $x+y = \frac{m-n}{g} = 52.19$, in the present case. It is certain, therefore, that whatever supposition be made with respect to the interval between x and y , their sum must always be the same, and must amount to 52.19 years. But that, that interval may be long enough to give the mean motions with exactness, it can scarcely be supposed less than 2000 years; and, in that case, $x = 3609$ years, which therefore is its least value. But if 3609 be reckoned back from 1700, it goes up to 1909 years before CHRIST; nearly, as has been said.

It must be remembered, that what is here investigated is the limit, or the most modern date possible to be assigned to the observations in question. The supposition that $x-y = a$, is the most probable of all, and it gives $x = 4801$, which corresponds to the beginning of the Calyougham.

* Mem. Acad. des Scien. 1786, p. 235, &c.

A FORMULA for computing the quantity of this inequality, has been given by M. DE LA PLACE, which, though only an approximation, being derived from theory, is more accurate than that which MAYER deduced entirely from observation * ; and if it be taken instead of MAYER's, which last, on account of its simplicity, I have employed in the preceding calculations, it will give a quantity somewhat different, though not such as to affect the general result. It makes the acceleration for 4383 years, dated from the beginning of the Calyougham, to be greater by $17', 39''$, than was found from MAYER's rule, and greater consequently by $16'. 32''$, than was deduced from the tables of Chrifnabouram. It is plain, that this coincidence is still near enough to leave the argument, that is founded on it, in possession of all its force, and to afford a strong confirmation of the accuracy of the theory, and the authenticity of the tables.

THAT observations made in India, when all Europe was barbarous or uninhabited, and investigations into the most subtle effects of gravitation made in Europe, near five thousand years afterwards, should thus come in mutual support of one another, is perhaps the most striking example of the progress and vicissitude of science, which the history of mankind has yet exhibited.

29 THIS, however, is not the only instance of the same kind that will occur, if, from examining the radical places and mean motions in the Indian astronomy, we proceed to consider some other of its elements, such as, the length of the year, the inequality of the sun's motion, and the obliquity of the ecliptic, and compare them with the conclusions deduced, from the theory of gravity, by M. DE LA GRANGE. To that geometer, physical astronomy is indebted for one of the most beautiful of its discoveries, *viz.* That all the variations in our system are periodical; so that though every thing, almost without excep-
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* Mem. Acad. des Scien. 1786, p. 260.

tion, be subject to change, it will, after a certain interval, return to the same state in which it is at present, and leave no room for the introduction of disorder, or of any irregularity that might constantly increase. Many of these periods, however, are of vast duration. A great number of ages, for instance, must elapse before the year be again exactly of the same length, or the sun's equation of the same magnitude as at present *. An astronomy, therefore, which professes to be so ancient as the Indian, ought to differ considerably from ours in many of its elements. If indeed these differences are irregular, they are the effects of chance, and must be accounted errors; but if they observe the laws, which theory informs us that the variations in our system do actually observe, they must be held as the most undoubted marks of authenticity. We are to examine, as M. BAILLY has done, which of these takes place in the case before us †.

30. THE tables of Tirvalore, which, as we have seen, refer their date to the beginning of the Calyougham, make the syderial year to consist of $365^d, 6^b, 12', 30''$; and therefore the tropical of $365^d, 5^b, 50', 35''$, which is $1', 46''$, longer than that of DE LA CAILLE ‡. Now, the tropical year was in reality longer at that time than it is at present; for though the syderial year, or the time which the earth takes to return from one point of space to the same point again, is always of the same magnitude, yet the tropical year being affected by the precession of the equinoxes, is variable by a small quantity, which never can exceed $3', 40''$, and which is subject to flow, and unequal alternations of diminution and increase. A theorem, expressing the law and the quantity of this variation, has been investigated by M. DE LA GRANGE, in the excellent Me-

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* Mem. de l'Acad. de Berlin, 1782, p. 170, &c.

† Ast. Ind. p. 160, &c.

‡ Supra, § 18. and 10.

moir already mentioned *; and it makes the year 3102 before CHRIST, $40''\frac{1}{2}$ longer than the year at the beginning of the present century †. The year in the tables of Tirvalore is therefore too great by $1', 5''\frac{1}{2}$.

31. BUT the determination of the year is always from a comparison of observations made at a considerable interval from one another; and, even to produce a degree of accuracy much less than what we see belongs to the tables of Tirvalore, that interval must have been of several ages. Now, says M. BAILLY, if we suppose these observations to have been made in that period of 2400 years, immediately preceding the Calyougham, to which the Brahmins often refer; and if we also suppose the inequality of the precession of the equinoxes, to increase as we go back, in proportion to the square of the times, we shall find, that, at the middle of this period, or 1200 years before the beginning of the Calyougham, the length of the year was $365^d, 5^h, 50', 41''$, almost precisely as in the tables of Tirvalore. And hence it is natural to conclude, that this determination of the solar year is as ancient as the year 1200 before the Calyougham, or 4300 before the Christian era ‡.

32. IN this reasoning, however, it seems impossible to acquiesce; and M. BAILLY himself does not appear to have relied on it with much confidence ||. We are not at liberty to suppose, that the precession of the equinoxes increases in the ratio above mentioned, or, which is the same, that the equinoctial points go back with a motion equably retarded. If, by M. DE GRANGE's formula, we trace back, step by step, the variation of the solar year, we shall find, that about the beginning of the Calyougham, it had nearly attained the extreme point of
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* Mem. Acad. Berlin, 1782. p. 289.

† Ast. Ind. p. 160.

‡ Ibid. p. 161.

|| He says, " Sans doute il ne peut résulter de ce calcul qu'un aperçu."

one of those vibrations, which many centuries are required to complete; and that the year was then longer than it has ever been since, or than it had been for many ages before. It was $40''\frac{1}{2}$ longer than it is at present; but, at the year 5500 before CHRIST, it was only $29''$ longer than at present, instead of $2'$, $50''$, which is the result of M. BAILLY's supposition. During all the intervening period of 2400 years, the variation of the year was between these two quantities; and we cannot therefore, by any admissible supposition, reduce the error of the tables to less than $1'$, $5''$. The smallness of this error, though extremely favourable to the antiquity, as well as the accuracy of the Indian astronomy, is a circumstance from which a more precise conclusion can hardly be deduced.

33. THE equation of the sun's centre is an element in the Indian astronomy, which has a more unequivocal appearance of belonging to an earlier period than the Calyougham. The maximum of that equation is fixed, in these tables, at 2° , $10'$, $32''$. It is at present, according to M. DE LA CAILLE, 1° , $55'\frac{1}{2}$, that is, $15'$ less than with the Brahmins. Now, M. DE LA GRANGE has shewn, that the sun's equation, together with the eccentricity of the earth's orbit, on which it depends, is subject to alternate diminution and increase, and accordingly has been diminishing for many ages. In the year 3102 before our era, that equation was 2° , $6'$, $28''\frac{1}{2}$; less, only by $4'$, than in the tables of the Brahmins. But if we suppose the Indian astronomy to be founded on observations that preceded the Calyougham, the determination of this equation will be found to be still more exact. Twelve hundred years before the commencement of that period, or about 4300 years before our era, it appears, by computing from M. DE LA GRANGE's formula, that the equation of the sun's centre was actually 2° , $8'$, $16''$; so that if the Indian astronomy be as old as that period, its error with respect to this equation is but of $2'*$.

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* Aft. Ind. p. 163.

34. THE obliquity of the ecliptic is another element in which the Indian astronomy and the European do not agree, but where their difference is exactly such as the high antiquity of the former is found to require. The Brahmins make the obliquity of the ecliptic 24° . Now, M. DE LA GRANGE's formula for the variation of the obliquity*, gives $22'$, $32''$, to be added to its obliquity in 1700, that is, to 23° , $28'$, $41''$, in order to have that which took place in the year 3102 before our era. This gives us 23° , $51'$, $13''$, which is $8'$, $47''$, short of the determination of the Indian astronomers. But if we suppose, as in the case of the sun's equation, that the observations on which this determination is founded, were made 1200 years before the Calyougham, we shall find that the obliquity of the ecliptic was 23° , $57'$, $45''$, and that the error of the tables did not much exceed $2'$ †.

35. THUS, do the measures which the Brahmins assign to these three quantities, the length of the tropical year, the equation of the sun's centre, and the obliquity of the ecliptic, all agree in referring the epoch of their determination to the year 3102 before our era, or to a period still more ancient. This coincidence in three elements, altogether independent of one another, cannot be the effect of chance. The difference, with respect to each of them, between their astronomy and ours, might singly perhaps be ascribed to inaccuracy; but that three errors, which chance had introduced, should be all of such magnitudes, as to suit exactly the same hypothesis concerning their origin, is hardly to be conceived. Yet there is no other alternative, but to admit this very improbable supposition, or to acknowledge that the Indian astronomy is as ancient as one, or other of the periods above mentioned.

36. THIS conclusion would receive great additional confirmation, could we follow M. BAILLY in his analysis of the astronomy

* Mem. Acad. Berlin, 1782, p. 287.

† Ast. Ind. p. 165.

nomy of the planets, contained in the tables of Chrisna-bouram *; but the length to which this *paper* is already extended, will allow only a few of the most remarkable particulars to be selected.

IN these tables, which are for the epoch 1491, the mean motions are given with considerable accuracy, but without an appearance of being taken from PTOLEMY, or any of the astronomers already mentioned. Two inequalities, called the *schigram* and the *manda*, are also distinguished in each of the planets, both superior and inferior †. The first of these is the same with that which we call the parallax of the earth's orbit, or the apparent inequality of a planet, which arises not from its own motion, but from that of the observer; but whether it is ascribed, in the Indian astronomy, to its true cause, or to the motion of the planet in an epicycle, is a question about which the tables give no direct information. The magnitude, however, of this equation is assigned, for each of the planets, with no small exactness, and is varied, in the different points of its orbit, by a law which approaches very near to the truth.

THE other inequality coincides with that of the planet's centre, or that which arises from the eccentricity of its orbit, and it is given near the truth for all the planets, except Mercury, by which, as is no wonder, the first astronomers were, every where, greatly deceived. Of this inequality, it is supposed, just as in the cases of the sun and moon, that it is always as the sine of the planet's distance from the point of its slowest motion, or from what we call its aphelion, and is consequently greatest at 90° from that point.

It were to be wished that we knew the etymology of the names which are given to these inequalities, as it might explain the theory which guided the authors of the tables. The titles of our astronomical tables, the terms *aphelion*, *heliocentric*
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* Ast. Ind. p. 173, &c.

† Ibid. p. 177.

or *geocentric place*, &c. would discover the leading ideas of the Copernican system, were no other description of it preserved.

37. IN the manner of applying these two inequalities, to correct the mean place of a planet, the rules of this astronomy are altogether singular. In the case of a superior planet, they do not make use of the mean anomaly, as the argument for finding out the equation *manda*, but of that anomaly, when corrected first by half the equation *schigram*, and afterwards by half the equation *manda* *. By the equation of the centre, obtained with this argument, the mean longitude of the planet is corrected, and its true heliocentric place consequently found, to which there is again applied the parallax of the annual orbit, that the geocentric place may be obtained. The only difficulty here, is in the method of taking out from the tables the equation to the centre. It is evidently meant for avoiding some inaccuracy, which was apprehended from a more direct method of calculation, but of which, even after the ingenious remarks of M. BAILLY, it seems impossible to give any clear and satisfactory account.

38. THE manner of calculating the places of the inferior planets has a great resemblance to the former; with this difference, however, that the equation *manda*, or of the centre, is applied to correct, not the mean place of the planet, but the mean place of the sun; and to this last, when so corrected, is applied the equation *schigram*, which involves the planet's elongation from the sun, and gives its geocentric place †. This necessarily implies, that the centre, about which the inferior planets revolve, has the same apparent mean motion with the sun: but whether it be a point really different from the sun, or the same; and, if the same, whether it be in motion or at rest, are left entirely undetermined, and we know not, whether, in the astronomy of India, we have here discovered a resemblance

* Ast. Ind. p. 194.

† Ibid. p. 199, &c.

blance to the Ptolemaic, the Tychonic, or the Copernican system.

39. THESE tables, though their radical places are for the year 1491 of our era, have an obvious reference to the great epoch of the Calyougham. For if we calculate the places of the planets from them, for the beginning of the astronomical year, at that epoch, we find them all in conjunction with the sun in the beginning of the moveable zodiac, their common longitude being $10^{\circ}, 6^{\circ}$ *. According to our tables, there was, at that time, a conjunction of all the planets, except Venus, with the sun; but they were, by no means, so near to one another as the Indian astronomy represents. It is true, that the exact time of a conjunction cannot be determined by direct observation: but this does not amount to an entire vindication of the tables; and there is reason to suspect, that some superstitious notions, concerning the beginning of the Calyougham, and the signs by which nature must have distinguished so great an epoch, has, in this instance at least, perverted the astronomy of the Brahmins. There are, however, some coincidences between this part of their astronomy, and the theory of gravity, which must not be forgotten.

40. THE first of these respects the aphelion of Jupiter, which, in the tables, is supposed to have a retrograde motion of 15° in 200,000 years †, and to have been, at the epoch of 1491, in longitude $5^{\circ}, 21^{\circ}, 40', 20''$, from the beginning of the zodiac. It follows, therefore, that in the year 3102 before CHRIST, the longitude of Jupiter's aphelion was $3^{\circ}, 27^{\circ}, 0'$, reckoned from the equinox. Now, the same, computed from M. DE LA LANDE's tables, is only $3^{\circ}, 16^{\circ}, 48', 58''$; so that there would seem to be an error of more than 10° in the tables of the Brahmins. But, if it be considered, that Jupiter's orbit

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* Aft. Ind. p. 181.

† Ibid. p. 184. § 13.

is subject to great disturbances, from the action of Saturn, which M. DE LA LANDE does not profess to have taken into account, we will be inclined to appeal once more to M. DE LA GRANGE's formulas, before we pass sentence against the Indian astronomy*.

FROM one of these formulas, we find, that the true place of the aphelion of Jupiter, at the time above mentioned, was $3^{\circ}, 26', 50'', 40''$, which is but $10', 40''$, different from the tables of Chrisnabouram. The French and Indian tables are therefore both of them exact, and only differ because they are adapted to ages near five thousand years distant from one another.

41. THE equation of Saturn's centre is an instance of the same kind. That equation, at present, is, according to M. DE LA LANDE, $6^{\circ}, 23', 19''$; and hence, by means of one of the formulas above mentioned, M. BAILLY calculates, that, 3102 years before CHRIST, it was $7^{\circ}, 41', 22''$ †. The tables of the Brahmins make it $7^{\circ}, 39', 44''$, which is less only by $1', 38''$, than the preceding equation, though greater than that of the present century by $1^{\circ}, 16', 25''$.

42. M. BAILLY remarks, that the equations for the other planets are not given with equal accuracy, and afford no more such instances as the former. But it is curious to observe, that new researches into the effects of gravitation, have discovered new coincidences of the same kind; and that the two great geometers, who have shared between them the glory of perfecting the *theory of disturbing forces*, have each contributed his part to establish the antiquity of the Indian astronomy. Since the publication of M. BAILLY's work, two other instances of an exact agreement, between the elements of these tables, and the conclusions deduced from the theory of gravity, have been observed, and communicated to him by M. DE LA PLACE, in a letter, inserted in the *Journal des Savans*.

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* Mem. Acad. Berlin. 1782, p. 246. Ast. Ind. p. 186.

† Ast. Ind. p. 188.

IN seeking for the cause of the secular equations, which modern astronomers have found it necessary to apply to the mean motion of Jupiter and Saturn, M. DE LA PLACE has discovered, that there are inequalities belonging to both these planets, arising from their mutual action on one another, which have long periods, one of them no less than 877 years; so that the mean motion must appear different, if it be determined from observations made in different parts of those periods. "Now," I find," says he, "by my theory, that at the Indian epoch of 3102 years before CHRIST, the apparent and annual mean motion of Saturn was 12° , $13'$, $14''$, and the Indian tables make it 12° , $13'$, $13''$.

"In like manner, I find, that the annual and apparent mean motion of Jupiter at that epoch was 30° , $20'$, $42''$, precisely as in the Indian astronomy *."

43. THUS have we enumerated no less than nine astronomical elements †, to which the tables of India assign such values as do, by no means, belong to them in these later ages, but such as the theory of gravity proves to have belonged to them three thousand years before the Christian era. At that time, therefore, or in the ages preceding it, the observations must have been made from which these elements were deduced. For it is abundantly evident, that the Brahmins of later times, however willing they might be to adapt their tables to so remarkable an epoch as the Calyougham, could never think of doing so, by substituting, instead of quantities which they had observed, others which they had no reason to believe had ever existed. The elements in question are precisely what these

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astronomers

* *Esprit des Journeaux*, Nov. 1787. p. 80.

† THE inequality of the precession of the equinoxes, (§ 22.); the acceleration of the moon; the length of the solar year; the equation of the sun's centre; the obliquity of the ecliptic; the place of Jupiter's aphelion; the equation of Saturn's centre; and the inequalities in the mean motion of both these planets.

astronomers must have supposed invariable, and of which, had they supposed them to change, they had no rules to go by for ascertaining the variations; since, to the discovery of these rules is required, not only all the perfection to which astronomy is, at this day, brought in Europe, but all that which the sciences of motion and of extension have likewise attained. It is no less clear, that these coincidences are not the work of accident; for it will scarcely be supposed that chance has adjusted the errors of the Indian astronomy with such singular felicity, that observers, who could not discover the true state of the heavens, at the age in which they lived, have succeeded in describing one which took place several thousand years before they were born.

44. THE argument, however, which regards the originality of these tables, is, in some measure, incomplete, till we have considered the geometrical principles which have been employed in their construction. For it is not impossible, that when seen connected by those principles, and united into general theorems, they may be found to have relations to the Greek astronomy, which did not appear, when the parts were examined singly. On this subject, therefore, I am now to offer a few observations.

45. THE rules by which the phenomena of eclipses are deduced from the places of the sun and moon, have the most immediate reference to geometry; and of these rules, as found among the Brahmins of Tirvalore, M. LE GENTIL has given a full account, in the Memoir that has been so often quoted. We have also an account of the method of calculation used at Chirsnabouram by Father DU CHAMP*.

IT is a necessary preparation, in both of these, to find the time of the sun's continuance above the horizon, at the place and the day for which the calculation of an eclipse is made, and the rule by which the Brahmins resolve this problem, is extremely simple
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* Ast. Ind. p. 355, &c.

and ingenious. At the place for which they calculate, they observe the shadow of a gnomon on the day of the equinox, at noon, when the sun, as they express it, is in the middle of the world. The height of the gnomon is divided into 720 equal parts, in which parts the length of the shadow is also measured. One third of this measure is the number of minutes by which the day, at the end of the first month after the equinox, exceeds twelve hours; four-fifths of this excess is the increase of the day during the second month; and one third of it is the increase of the day, during the third month*.

46. It is plain, that this rule involves the supposition, that, when the sun's declination is given, the same ratio every where exists between the arch which measures the increase of the day at any place, and the tangent of the latitude; for that tangent is the quotient which arises from dividing the length of the shadow by the height of the gnomon. Now, this is not strictly true; for such a ratio only subsists between the chord of the arch, and the tangent above mentioned. The rule is, therefore, but an approximation to the truth, as it necessarily supposes the arch in question to be so small as to coincide nearly with its chord. This supposition holds only of places in low latitudes; and the rule which is founded on it, though it may safely be applied in countries between the tropics, in those that are more remote from the equator, would lead into errors too considerable to escape observation †.

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* Mem. Acad. des Scien. II. P. 175.

† To judge of the accuracy of this approximation, suppose O to be the obliquity of the ecliptic, and x the excess of the semidiurnal arch, on the longest day, above an arch of 90° , then $\sin. x = \tan. O \times \tan. lat.$ But if G be the height of a gnomon, and S the length of its shadow on the equinoctial day, $\frac{S}{G} = \tan. lat.$ and $\sin. x = \tan. O \times \frac{S}{G}$.

Therefore $x = \tan. O \times \frac{S}{G} + \frac{\tan. O^3 \times S^3}{6G^3} + \frac{\tan. O^5 \times S^5}{24G^5} + \&c.$ or in minutes of time,

As some of the former rules, therefore, have served to fix the time, so does this, in some measure, to ascertain the place of its invention. It is the simplification of a general rule, adapted to the circumstances of the torrid zone, and suggested to the astronomers of Hindostan by their peculiar situation. It implies the knowledge of the circles of the sphere, and of spherical trigonometry, and perhaps argues a greater progress in mathematical reasoning, than a theorem that was perfectly accurate would have done. The first geometers must naturally have dreaded nothing so much as any abatement in the rigour of their demonstrations, because they would see no limits to the error and uncertainty, in which they might, by that means, be involved. It was long before the mathematicians of Greece understood how to set bounds to such errors, and to ascertain their utmost extent, whether on the side of excess or defect; in this art, they appear to have received the first lessons so late as the age of ARCHIMEDES.

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time, reckoned after the Indian manner, $x = 572.957 \left(\tan.O \times \frac{S}{G} + \tan.O^3 \times \frac{S^3}{6G^3} + \&c. \right)$

If $O = 24^\circ$, then $\tan.O = .4452$, and the first term of this formula gives $x = 572.957 \times \frac{.4452S}{G} = \frac{255S}{G}$, which is the same with the rule of the Brahmins.

For that rule, reduced into a formula, is $2x = \frac{720S}{G} \left(\frac{1}{3} + \frac{4}{15} + \frac{1}{9} \right) = \frac{512S}{G}$, or $x = \frac{256S}{G}$.

THEY have therefore computed the coefficient of $\frac{S}{G}$ with sufficient accuracy; the error produced by the omission of the rest of the terms of the series will not exceed 1', even at the tropics, but, beyond them, it increases fast, and, in the latitude of 45° , would amount to 8'.

47. THE Brahmins having thus obtained the variations of the length of the day, at any place, or what we call the ascensional differences, apply them likewise to another purpose. As they find it necessary to know the point of the ecliptic, which is on the horizon, at the time when an eclipse happens, they have calculated a table of the right ascensions of the points of the ecliptic in time, to which they apply the ascensional differences for the place in question, in order to have the time which each of the signs takes to descend below the horizon of that place *. This is exactly the method, as is well known, which the most skilful astronomer, in like circumstances, would pursue. Their table of the differences of right ascension is but for a few points in the ecliptic, *viz.* the beginning of each sign, and is only carried to minutes of time, or tenths of a degree. It is calculated, however, so far as it goes, with perfect accuracy, and it supposes the obliquity of the ecliptic, as before, to be twenty-four degrees.

SUCH calculations could not be made without spherical trigonometry, or some method equivalent to it. If, indeed, we would allow the least skill possible to the authors of these tables, we may suppose, that the arches were measured on the circles of a large globe, or armillary sphere, such as we know to have been one of the first instruments of the Egyptian and Greek astronomers. But there are some of the tables where the arches are put down true to seconds, a degree of accuracy which a mechanical method can scarcely have afforded.

48. IN another part of the calculation of eclipses, a direct application is made of one of the most remarkable propositions in geometry. In order to have the semiduration of a solar eclipse, they subtract from the square of the sum of the semidiameters of the sun and moon, the square of a certain line, which is a perpendicular from the centre of the sun on the path of the moon; and from the remainder, they extract
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* Acad. des Scien. 1772, II. P. 205.

the square root, which is the measure of the semiduration *. The same thing is practised in lunar eclipses †. These operations are all founded on a very distinct conception of what happens in the case of an eclipse, and on the knowledge of this theorem, that, in a right-angled triangle, the square on the hypotenuse is equal to the squares on the other two sides. It is curious to find the theorem of PYTHAGORAS in India, where, for aught we know, it may have been discovered, and from whence that philosopher may have derived some of the solid, as well as the visionary speculations, with which he delighted to instruct or amuse his disciples.

49. WE have mentioned the use that is made of the semidiameters of the sun and moon in these calculations, and the method of ascertaining them, is deserving of attention. For the sun's apparent diameter, they take four-ninths of his diurnal motion, and for the moon's diameter, one twenty-fifth of her diurnal motion. In an eclipse, they suppose the section of the shadow of the earth, at the distance of the moon, to have a diameter five times that of the moon; and in all this, there is considerable accuracy, as well as great simplicity. The apparent diameters of the sun and moon, increase and diminish with their angular velocities; and though there be a mistake in supposing, that they do so exactly in the same proportion, it is one which, without telescopes and micrometers, cannot easily be observed. The section of the earth's shadow, likewise, if the sun's apparent diameter be given, increases as the moon's increases, or as her distance from the earth diminishes, and nearly enough in the same ratio to justify the rule which is here laid down.

50. THE historian of the Academy of Sciences, in giving an account of M. LE GENTIL's Memoir, has justly observed, that
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* Mem. Acad. des Scien. 1772, II. P. 259.

† Ibid. 241.

the rule described in it, for finding the difference between the true and apparent conjunction, at the time of a solar eclipse, contains the calculation of the moon's parallax, but substitutes the parallax in right ascension for the parallax in longitude*; an error which the authors of this astronomy would probably have avoided, had they derived their knowledge from the writings of PTOLEMY. From this supposed parallax in longitude, they next derive the parallax in latitude, where we may observe an application of the doctrine of similar triangles; for they suppose the first of these to be to the last in the constant ratio of 25 to 2, or nearly as the radius to the tangent of the inclination of the moon's orbit to the plane of the ecliptic. We have here, therefore, the application of another geometrical theorem, and that too proceeding on the supposition, that a small portion of the sphere, on each side of the point which the sun occupies at the middle of the eclipse, may be held to coincide with a plane touching it in that point.

51. THE result which the Brahmins thus obtain will be allowed to have great accuracy, if it be considered how simple their rules are, and how long it must be since their tables were corrected by observations. In two eclipses of the moon, calculated in India by their method, and likewise observed there by M. LE GENTIL, the error, in neither case, exceeded 23' of time, (corresponding to one of 13' of a degree, in the place of the moon); and in the duration and magnitude of the eclipse, their calculation came still nearer to the truth†.

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* Hist. Acad. II. P. 109. Ibid. Mem. 253,—256.

† In the language, however, of their rules, we may trace some marks of a fabulous and ignorant age; from which indeed even the astronomy of Europe is not altogether free. The place of the moon's ascending node, is with them *the place of the Dragon* or *the Serpent*; the moon's distance from the node, is literally translated by M. LE GENTIL, *la*

52. SINCE an inequality was first observed in the motions of the sun or moon, the discovery of the law which it follows, and the method of determining the quantity of it, in the different points of their orbits, has been a problem of the greatest importance ; and it is curious to inquire, in what manner the astronomers of India have proceeded to resolve it. For this purpose, we must examine the tables of the *chaiaa*, or equations of the centre for the sun and moon, and of the *manda*, or equations of the centre for the planets. With respect to the first, as contained in the tables of Siam, M. CASSINI observed, that the equations followed the ratio of the sines of the mean distances from the apogee ; but as they were calculated only for a few points of the orbit, it could not be known with what degree of exactness this law was observed. Here, however, the tables of Chirfnabouram remove the uncertainty, as they give the equation of the centre for every degree of the mean motion, and make it nearly as the sine of the distance from the apogee.

THEY do so, however, only nearly ; and it will be found on trial, that there is, in the numbers of the table, a small, but regular variation from this law, which is greatest when the argument is 30° , though even there it does not amount to a minute. The sun's equation, for instance, which, when greatest, or when the argument is 90° , is, by these tables, $2^\circ, 10', 32''$, should be, when the argument is 30° , just the half of this, or $1^\circ, 5', 16''$, did the numbers in the table follow exactly the ratio

la lune offensée du dragon. Whether it be that we have borrowed these absurdities from India, along with astrology, or if the popular theory of eclipses has, at first, been every where the same, the moon's node is also known with us by the name of the *cauda draconis*. In general, however, the signification of the terms in these rules, so far as we know it, is more rational. In one of them we may remark considerable refinement ; *ayanangsam*, which is the name for the reduction made on the sun's longitude, on account of the precession of the equinoxes, is compounded from *ayanam*, a *course*, and *angsam*, an *atom*. Mem. Acad. II. P. 251. The equinox is almost the only point not distinguished by a visible object, of which the *course* or motion is computed in this astronomy.

ratio of the sines of the argument. It is, however, 1° , $6'$, $3''$; and this excess of $47''$ cannot have arisen from any mistake about the ratio of the sine of 30° to that of 90° , which is shewn to be that of 1 to 2, by a proposition in geometry* much too simple to have been unknown to the authors of these tables. The rule, therefore, of the equations, being proportional exactly to the sines of the argument, is not what was followed, or intended to be followed, in the calculation of them. The differences, also, between the numbers computed by that rule, and those in the tables, are perfectly regular, decreasing from the point of 30° , both ways toward the beginning and end of the quadrant, where they vanish altogether.

THESE observations apply also to the tables of Narsapur †, and to the moon's equations, as well as to the sun's, with a circumstance, however, which is not easily accounted for, *viz.* that the differences between the numbers calculated by M. CASSINI's rule, and those in the tables, are not greater in the case of the moon than of the sun, though the equation of the latter be more than double that of the former. They apply also to the tables *manda* of the planets, where the equations are greater than the ratio of the sines of their arguments requires, the excess being greatest at 30° , and amounting to some minutes in the equations of Saturn, Jupiter and Mars, in which last it is greatest of all!

53. THOUGH, for these reasons, it is plain, that the rule of M. CASSINI is not the same with that of the Brahmins, it certainly includes the greater part of it; and if the latter, whatever it may have been, were expressed in a series, according to the methods of the modern analysis, the former would be the first term of that series. We are not, however, much advanced in our inquiry in consequence of this remark; for the first terms of all the series, which can, on any hypothesis, express

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* Euc. Lib. IV. Prop. 15.

† See these tables, *Ast. Ind.* p. 414.

the relation of the equation of the centre to the anomaly of a planet, are so far the same, that they are proportional to the sine of that anomaly; and it becomes therefore necessary to search among these hypotheses, for that by which the series of small differences, described above, may be best represented. It is needless to enter here into any detail of the reasonings by which this has been done, and by which I have found, that the argument in the table bears very nearly the same relation to the corresponding numbers, that the anomaly of the eccentric does to the equation of the centre. By the anomaly of the eccentric, however, I do not mean the angle which is known by that name in the solution of KEPLER's problem, but that which serves the same purpose with it, on the supposition of a circular orbit, and an uniform angular motion about a point which is not the centre of that orbit, but which is as distant from it, on the one side, as the earth (or the place of the observer) is on the other. It is the angle, which, in such an orbit, the line drawn from the planet to the centre, makes with the line drawn from thence to the apogee; and the argument in the Indian tables coincides with this angle.

THIS hypothesis of a double eccentricity, is certainly not the simplest that may be formed with respect to the motion of the heavenly bodies, and is not what one would expect to meet with here; but it agrees so well with the tables, and gives the equations from the arguments so nearly, especially for the moon and the planets, that little doubt remains of its being the real hypothesis on which these tables were constructed*.

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* THE formula deduced from this hypothesis, for calculating the equation of the centre from the anomaly of the eccentric, is the following: Let α be the equation of the centre, ϕ the anomaly of the eccentric, e the eccentricity of the orbit, or the tangent of

half the greatest equation; then $\alpha = 2e \sin \phi + \frac{2e^3 \sin 3\phi}{3} + \frac{2e^5 \sin 5\phi}{5} + \&c.$

54. OF this, the method employed to calculate the place of any of the five planets from these tables, affords a confirmation. But, in reasoning about that method, it is necessary to put out of the question the use that is made of the parallax of the annual orbit, or of the *schigram*, in order to have the argument for finding the equation of the centre, which is evidently faulty, as it makes that equation to be affected by a quantity, (the parallax of the annual orbit), on which it has in reality no dependence. To have the rule free from error, it is to be taken, therefore, in the case when there is no parallax of the annual orbit, that is, when the planets are in opposition or conjunction with the sun. In that case, the mean anomaly is first corrected by the subtraction or addition of half the equation that belongs to it in the table. It then becomes the true argument for finding, from that same table, the equation of the centre, which is next applied to the mean anomaly, to have the true. Now, this agrees perfectly with the conclusion above; for the mean anomaly, by the subtraction or addition of half the equation belonging to it in the table, is converted, almost precisely, into the anomaly of the eccentric, and becomes therefore the proper argument for finding out the equation, which is to change the mean anomaly into the true*. There can be no doubt, of consequence, that the conclusion we have come to is strictly applicable to the planets, and that the orbit of each of them, in this astronomy, is supposed to be a circle, the earth not being in its centre, but the angular

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velocity

* THIS method of calculation is so nearly exact, that even in the orbit of Mars, the equation calculated from the mean anomaly, rigorously on the principle of his angular motion being uniform, about a point distant from the centre, as described above, will rarely differ a minute from that which is taken out from the Indian tables by this rule. It was remarked, (§ 37.) that it is not easy to explain the rules for finding the argument of the equation of the centre, for the planets. What is said here explains fully one part of that rule, *viz.* the correction made by half the equation *manda*; the principle on which the other part proceeds, *viz.* the correction by half the equation *schigram*, is still uncertain.

velocity of the planet being uniform about a certain point, as far from that centre on the one side, as the earth is on the opposite.

55. BETWEEN the structure of the tables of the equations of the sun and moon, and the rules for using them, there is not the same consistency; for in both of them, the argument, which we have found to be the eccentric anomaly, is nevertheless treated as the mean. So far as concerns the sun, this leads to nothing irreconcilable with our supposition, because the sun's equation being small, the difference will be inconsiderable, whether the argument of that equation be treated as the eccentric or the mean anomaly.

BUT it is otherwise with respect to the moon, where the difference between considering the argument of the equation as the mean, or as the eccentric anomaly, is not insensible. The authority of the precepts, and of the tables, are here opposed to one another; and we can decide in favour of the latter, only because it leads to a more accurate determination of the moon's place than the former. It would indeed be an improvement on their method of calculation, which the Brahmins might make consistently with the principles of their own astronomy, to extend to the moon their rule for finding the equation of the centre for the planets. They would then avoid the palpable error of making the maximum of the moon's equation at the time when her mean anomaly is 90° , and would ascertain her place every where with greater exactness. It is probable that this is the method which they were originally directed to follow.

56. FROM the hypothesis which is thus found to be the basis of the Indian astronomy, one of the first conclusions which presents itself, is the existence of a remarkable affinity between the system of the Brahmins and that of PTOLEMY. In the latter, the same thing was supposed for the five planets,
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that appears in the former to have been universally established, *viz.* that their orbits were circles, having the earth within them, but removed at a small distance from the centre, and that each planet described the circumference of its orbit, not with an uniform velocity, but with one that would appear uniform, if it were viewed from a point as far above the centre of the orbit, as that centre is above the earth. This point was, in the language of PTOLEMY's astronomy, the centre of the *Equant*.

Now, concerning this coincidence, it is the more difficult to judge, as, on the one hand, it cannot be ascribed to accident, and, on the other, it may be doubted, whether it arises necessarily out of the nature of the subject, or is a consequence of some unknown communication between the astronomers of India and of Greece.

THE first hypothesis by which men endeavoured to explain the phenomena of the celestial motions, was that of a uniform motion in a circle, which had the earth for its centre. This hypothesis was, however, of no longer continuance than till instruments of tolerable exactness were directed to the heavens. It was then immediately discovered, that the earth was not the centre of this uniform motion; and the earth was therefore supposed to be placed at a certain distance from the centre of the orbit, while the planet revolved in the circumference of it with the same velocity as before. Both these steps may be accounted necessary; and in however many places of the earth, and however cut off from mutual intercourse, astronomy had begun to be cultivated, I have no doubt that these two suppositions would have succeeded one another, just as they did among the Greek astronomers.

BUT when more accurate observations had shewn the insufficiency even of this second hypothesis, what ought naturally to be the third, may be thought not quite so obvious; and if the Greeks made choice of that which has been described above, it
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may seem to have been owing to certain metaphysical notions concerning the simplicity and perfection of a circular and uniform motion, which inclined them to recede from that supposition, no farther than appearances rendered absolutely necessary. The same coincidence between the ideas of metaphysics and astronomy, cannot be supposed to have taken place in other countries; and therefore, where we find this third hypothesis to have prevailed, we may conclude that it was borrowed from the Greeks.

57. THOUGH it cannot be denied, that, in this reasoning, there is some weight, yet it must be observed, that the introduction of the third hypothesis did not rest among the Greeks altogether on the coincidence above mentioned. It was one suited to their progress in mathematical knowledge, and offered almost the only system, after the two former were exploded, which rendered the planetary motions the subject of geometrical reasoning, to men little versed in the methods of approximation. This was the circumstance then, which, more than any other, probably influenced them in the choice of this hypothesis, though we are not to look for it as an argument stated in their works, but may judge of the influence it had, from the frequency with which, many ages afterwards, the *αγεωμετρησια* of KEPLER's system was objected to him by his adversaries; an objection to which that great man seemed to pay more attention than it deserved.

THERE is reason therefore to think, that in every country where astronomy and geometry had neither of them advanced beyond a certain point, the hypothesis of the equant would succeed to that of a simple eccentric orbit, and therefore cannot be admitted as a proof, that the different systems in which it makes a part, are necessarily derived from the same source. Some other circumstances attending this hypothesis, as it is found in the Indian tables, go still farther, and seem quite inconsistent with the supposition that the authors of these tables
derived

derived it from the astronomers of the west. For, *first*, It is applied by them to all the heavenly bodies, that is, to the sun and moon, as well as the planets. With PTOLEMY, and with all those who founded their systems on his, it extended only to the latter, inasmuch that KEPLER's great reformation in astronomy, the discovery of the elliptic orbits, began from his proving, that the hypothesis of the equant was as necessary to be introduced for the sake of the sun's orbit, as for those of the planets, and that the eccentricity in both cases, must be bisected. It is, therefore, on a principle no way different from this of KEPLER, that the tables of the sun's motion are computed in the Indian astronomy, though it must be allowed, that the method of using them is not perfectly consistent with this idea of their construction.

2dly, THE use made of the anomaly of the eccentric in these tables, as the argument of the equation of the centre, is altogether peculiar to the Indian astronomy. PTOLEMY's tables of that equation for the planets, though they proceed on the same hypothesis, are arranged in a manner entirely different, and have for their argument the mean anomaly. The angle which we call the anomaly of the eccentric, and which is of so much use in the Indian tables, is not employed at all in the construction of his *, nor, I believe, in those of any other astronomer till the time of KEPLER; and even by KEPLER it was not made the argument of the equation to the centre. The method, explained above, of converting the mean anomaly into that of the eccentric, and consequently into the argument of the equation, is another peculiarity, and though simple and ingenious, has not the accuracy suited to the genius of the Greek astronomy, which never admitted even of the best approximation, when a rigorous solution could be found; and, on the whole, if the resemblance of these two systems, even with all the exceptions that have been stated, must still be ascribed

to

* Almagest. lib. XI. cap. 9. & 10.

to some communication between the authors of them, that communication is more likely to have gone from India to Greece, than in the opposite direction. It may perhaps be thought to favour this last opinion, that PTOLEMY has no where demonstrated the necessity of assigning a double eccentricity to the orbits of the planets, and has left room to suspect, that authority, more than argument, has influenced this part of his system.

58. IN the tables of the planets, we remarked another equation, (*schigram*) answering to the parallax of the earth's orbit, or the difference between the heliocentric and the geocentric place of the planet. This parallax, if we conceive a triangle to be formed by lines drawn from the sun to the earth and to the planet, and also from the planet to the earth, is the angle of that triangle, subtended by the line drawn from the sun to the earth. And so, accordingly, it is computed in these tables; for if we resolve such a triangle as is here described, we will find the angle, subtended by the earth's distance from the sun, coincide very nearly with the *schigram*.

THE argument of this equation is the difference between the mean longitude of the sun and of the planet. The orbits are supposed circular; but whether the inequality in question was understood to arise from the motion of the earth, or from the motion of the planet in an epicycle, the centre of which revolves in a circle, is left undetermined, as both hypotheses may be so adjusted as to give the same result with respect to this inequality. The proportional distances of the planets from the earth or the sun, may be deduced from the tables of these equations, and are not far from the truth.

59. THE preceding calculations must have required the assistance of many subsidiary tables, of which no trace has yet been found in India. Besides many other geometrical propositions, some of them also involve the ratio, which the diameter of a circle was supposed to bear to its circumference, but which

we would find it impossible to discover from them exactly, on account of the small quantities that may have been neglected in their calculations. Fortunately, we can arrive at this knowledge, which is very material when the progress of geometry is to be estimated, from a passage in the *Ayeeen Akbery*, where we are told, that the Hindoos suppose the diameter of a circle to be to its circumference as 1250 to 3927 *, and where the author, who knew that this was more accurate than the proportion of ARCHIMEDES, (7 to 22), and believed it to be perfectly exact, expresses his astonishment, that among so simple a people, there should be found a truth, which, among the wisest and most learned nations, had been sought for in vain.

THE proportion of 1250 to 3927 is indeed a near approach to the quadrature of the circle; it differs little from that of METIUS, 113 to 355, and is the same with one equally remarkable, that of 1 to 3.1416. When found in the simplest and most elementary way, it requires a polygon of 768 sides to be inscribed in a circle; an operation which cannot be arithmetically performed without the knowledge of some very curious properties of that curve, and, at least, nine extractions of the square root, each as far as ten places of decimals. All this must have been accomplished in India; for it is to be observed, that the above mentioned proportion cannot have been received from the mathematicians of the west. The Greeks left nothing on this subject more accurate than the theorem of ARCHIMEDES; and the Arabian mathematicians, seem not to have attempted any nearer approximation. The geometry of modern Europe can much less be regarded as the source of this knowledge. METIUS and VIETA were the first, who, in the quadrature of the circle, surpassed the accuracy of ARCHIMEDES; and they flourished at the very time when the Institutes of AKBAR were collected in India.

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* *Ayeeen Akbery*, Vol. III. p. 32.

60. ON the grounds which have now been explained, the following general conclusions appear to be established.

1. THE observations on which the astronomy of India is founded, were made more than three thousand years before the Christian era ; and, in particular, the places of the sun and moon, at the beginning of the Calyougham, were determined by actual observation.

THIS follows from the exact agreement of the radical places in the tables of Tirvalore, with those deduced for the same epoch from the tables of DE LA CAILLE and MAYER, and especially in the case of the moon, when regard is had to her acceleration. It follows, too, from the position of the fixed stars in respect of the equinox, as represented in the Indian zodiac ; from the length of the solar year ; and, lastly, from the position and form of the orbits of Jupiter and Saturn, as well as their mean motions ; in all of which, the tables of the Brahmins, compared with ours, give the quantity of the change that has taken place, just equal to that which the action of the planets on one another may be shown to have produced, in the space of forty-eight centuries, reckoned back from the beginning of the present.

TWO other of the elements of this astronomy, the equation of the sun's centre, and the obliquity of the ecliptic, when compared with those of the present time, seem to point to a period still more remote, and to fix the origin of this astronomy 1000 or 1200 years earlier, that is, 4300 years before the Christian era ; and the time necessary to have brought the arts of calculating and observing to such perfection as they must have attained at the beginning of the Calyougham, comes in support of the same conclusion.

OF such high antiquity, therefore, must we suppose the origin of this astronomy, unless we can believe, that all the coincidences

cidences which have been enumerated, are but the effects of chance ; or, what indeed were still more wonderful, that, some ages ago, there had arisen a NEWTON among the Brahmins, to discover that universal principle which connects, not only the most distant regions of space, but the most remote periods of duration ; and a DE LA GRANGE, to trace, through the immensity of both, its most subtle and complicated operations.

II. THOUGH the astronomy which is now in the hands of the Brahmins, is so ancient in its origin, yet it contains many rules and tables that are of later construction.

THE first operation for computing the moon's place from the tables of Tirvalore, requires that 1,600,984 days should be subtracted from the time that has elapsed since the beginning of the Calyougham, which brings down the date of the rule to the year 1282 of our era. At this time, too, the place of the moon, and of her apogee, are determined with so much exactness, that it must have been done by observation, either at the instant referred to, or a few days before or after it. At this time, therefore, it is certain, that astronomical observations were made in India, and that the Brahmins were not, as they are now, without any knowledge of the principles on which their rules are founded. When that knowledge was lost, will not perhaps be easily ascertained ; but there are, I think, no circumstances in the tables from which we can certainly infer the existence of it at a later period than what has just been mentioned ; for though there are more modern epochs to be found in them, they are such as may have been derived from the most ancient of all, by help of the mean motions in the tables of Chirsnabouram *, without any other skill than is required to an ordinary calculation. Of these epochs, beside what have been occasionally mentioned in the course of our remarks, there is one (involved in the tables of Narfapur) as late as the year 1656, and another as early as the year 78 of our era,

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which

* Ast. Ind. p. 307.

which marks the death of *SAHYAGANNA*, one of their princes, in whose reign a reform is said to have taken place in the methods of their astronomy. There is no reference to any intermediate date, from that time to the beginning of the Calyougham.

THE parts of this astronomy, therefore, are not all of the same antiquity: nor can we judge, merely from the epoch to which the tables refer, of the age, to which they were originally adapted. We have seen, that the tables of *Chrishnabouram*, though they profess to be no older than the year 1491 of our era, are, in reality, more ancient than the tables of *Tirvalore*, which are dated from the *Calyougham*, or at least have undergone fewer alterations. This we concluded from the slow motion given to the moon, in the former of these tables, which agreed, with such wonderful precision, with the secular equation applied to that planet by *MAYER*, and explained by *M. DE LA PLACE*.

BUT it appears, that neither the tables of *Tirvalore* or *Chrishnabouram*, nor any with which we are yet acquainted, are the most ancient to be found in India. The Brahmins constantly refer to an astronomy at *Benares*, which they emphatically style *the ancient* *, and which they say is not now understood by them, though they believe it to be much more accurate than that by which they calculate. That it is more accurate, is improbable; that it may be more ancient, no one who has duly attended to the foregoing facts and reasonings, will think impossible; and every one, I believe, will acknowledge, that no greater service could be rendered to the learned world, than to rescue this precious fragment from obscurity. If that is ever to be expected, it is when the zeal for knowledge has formed a literary society among our countrymen in Bengal, and while that society is directed by the learning and abilities of Sir *WILLIAM JONES*. Indeed, the farther discoveries

* *Ast. Ind.* p. 309. *M. LE GENTIL*, *Mem. Acad. Scien.* 1772. P. II. p. 221.

ries which may be made with respect to this science, do not interest merely the astronomer and the mathematician, but every one who delights to mark the progress of mankind, or is curious to look back on the ancient inhabitants of the globe. It is through the medium of astronomy alone that a few rays from those distant objects can be conveyed in safety to the eye of a modern observer, so as to afford him a light, which, though it be scanty, is pure and unbroken, and free from the false colourings of vanity and superstition.

III. THE basis of the four systems of astronomical tables which we have examined, is evidently the same.

THOUGH these tables are scattered over an extensive country, they seem to have been all originally adapted, either to the same meridian, or to meridians at no great distance, which traverse what we may call the classical ground of India, marked by the ruins of Canoge, Palibothra and Benares. They contain rules that have originated between the tropics; whatever be their epoch, they are all, by their mean motions, connected with that of the Calyougham; and they have besides one uniform character which it is perhaps not easy to describe. Great ingenuity has been exerted to simplify their rules; yet, in no instance almost, are they reduced to the utmost simplicity; and when it happens that the operations to which they lead are extremely obvious, these are often involved in an artificial obscurity. A Brahmin frequently multiplies by a greater number than is necessary, where he seems to gain nothing but the trouble of dividing by one that is greater in the same proportion; and he calculates the era of SALIVAGANAM with the formality of as many distinct operations as if he were going to determine the moon's motion since the beginning of the Calyougham. The same spirit of exclusion, the same fear of communicating his knowledge, seems to direct the calculus which pervades the religion of the Brahmin; and, in neither of them, is he willing to receive or to impart instruction. With all these circumstances of resemblance,

blance, the methods of this astronomy are as much diversified as we can suppose the same system to be, by passing through the hands of a succession of ingenious men, fertile in resources, and acquainted with the variety and extent of the science which they cultivated. A system of knowledge, which is thus assimilated to the genius of the people, that is diffused so widely among them, and diversified so much, has a right to be regarded, either as a native, or a very ancient inhabitant of the country where it is found.

IV. THE construction of these tables implies a great knowledge of geometry, arithmetic, and even of the theoretical part of astronomy.

IN proof of this, it is unnecessary to recapitulate the remarks that have been already made. It may be proper, however, to add, that the method of calculating eclipses, to which these tables are subservient, is, in no respect, an empirical one; founded on the mere observation of the intervals at which eclipses return, one after another, in the same order. It is indeed remarkable, that we find no trace here of the period of 6585 days and 8 hours, or 223 lunations, the *Saros* of the Chaldean astronomers, which they employed for the prediction of eclipses, and which (observed with more or less accuracy) the first astronomers every where must have employed, before they were able to analyse eclipses, and to find out the laws of every cause contributing to them. That empirical method, if it once existed in India, is now forgotten, and has long since given place to the more scientific and accurate one, which offers a complete analysis of the phenomena, and calculates, one by one, the motions of the sun, of the moon, and of the node.

BUT what, without doubt, is to be accounted the greatest refinement in this system, is the hypothesis employed in calculating the equations of the centre for the sun, moon and planets, that, *viz.* of a circular orbit having a double eccentricity,
or

or having its centre in the middle, between the earth and the point about which the angular motion is uniform *. If to this we add the great extent of geometrical knowledge requisite to combine

* It should have been remarked before, that M. BAILLY has taken notice of the analogy between the Indian method of calculating the places of the planets, and PROLEMY's hypothesis of the equant, though on different principles from those that have been followed here, and such as do not lead to the same conclusion. In treating of the question, whether the sun or earth has been supposed the centre of the planetary motions by the authors of this astronomy, he says, " Ils semblent avoir reconnu que les deux inégalités (l'équation du centre et la parallaxe de l'orbe annuel) étoient vues de deux centres differens ; et dans l'impossibilité où ils étoient de déterminer et le lieu et la distance des deux centres, ils ont imaginé de rapporter les deux inégalités à un point qui tint le milieu, c'est-à-dire, à un point également éloigné du soleil, et de la terre. Ce nouveau centre ressemble assez au centre de l'équant de PROLEMEE. (Astr. Ind. Disc. Prel. p. 69.) The fictitious centre, which M. BAILLY compares with the equant of PROLEMY, is therefore a point which bisects the distance between the sun and earth, and which, in some respects, is quite different from that equant ; the fictitious centre, which, in the preceding remarks, is compared with the equant of PROLEMY, is a point of which the distance from the earth is bisected by the centre of the orbit, precisely as in the case of that equant. M. BAILLY draws his conclusion from the use made of half the equation *schigram*, as well as half the equation *manda*, in order to find the argument of this last equation. The conclusion here is established, by abstracting altogether from the former, and considering the cases of oppositions and conjunctions, when the latter equation only takes place. If, however, the hypothesis of the equant shall be found of importance in the explanation of the Indian astronomy, it must be allowed that it was first suggested by M. BAILLY, though in a sense very different from what it is understood in here, and from what it was understood in by PROLEMY.

For what farther relates to the parts of the astronomy of Chaldea and of Greece, which may be supposed borrowed from that of India, I must refer to the 10th Chap. of the *Astronomie Indienne*, where that subject is treated with great learning and ingenuity. After all, the silence of the ancients with respect to the Indian astronomy, is not easily accounted for. The first mention that is made of it, is by the Arabian writers ; and M. BAILLY quotes a very singular passage, where MASSOUDI, an author of the 12th century, says, that BRAMA composed a book, entitled, *Sind-Hind*, that is, *Of the Age of Ages*, from which was composed the book *Maghissi*, and from thence the *Almagest* of PROLEMY. Astr. Ind. Disc. prel. p. 175.

The fabulous air of this passage is, in some measure, removed, by comparing it with one from ABULFARAGIUS, who says, that, under the celebrated AL MAIMON, the 7th Khalif of Babylon, (about the year 813 of our era) the astronomer HABASH composed three sets of astronomical tables, one of which was *ad regulas Sind Hind* ; that is, as Mr COSTARD explains it, according to the rules of some Indian treatise of astronomy. (Asiatic Miscel. Vol. I. p. 34.) The *Sind-Hind* is therefore the name of an astronomical book that existed in India in the time of HABASH, and the same, no doubt, which MASSOUDI says was ascribed to BRAMA.

combine this, and the other principles of their astronomy together, and to deduce from them the just conclusions ; the possession of a calculus equivalent to trigonometry ; and, lastly, their approximation to the quadrature of the circle, we shall be astonished at the magnitude of that body of science, which must have enlightened the inhabitants of India in some remote age, and which, whatever it may have communicated to the western nations, appears to have received nothing from them.

SUCH are the conclusions that seem to me to follow, with the highest probability, from the facts which have been stated. They are, without doubt, extraordinary ; and have no other claim to our belief, except that, as I think has been fully proved, their being false were much more wonderful than their being true. There are but few things, however, of which the contrary is impossible. It must be remembered, that the whole evidence on this subject is not yet before the public, and that the repositories of Benares may contain what is to confirm or to invalidate these observations.

XIV. *On the RESOLUTION of INDETERMINATE PROBLEMS.* By JOHN LESLIE, A. M.

[*Read by Mr PLATFAIR, Dec. 1. 1788.*]

IT is a fundamental principle in Algebra, that a problem admits of solution, when the number of independent equations is equal to that of the unknown quantities. If simple expressions only occur, the answers will always be found in numbers, either whole or fractional. But if the higher functions be concerned, the values of the unknown quantities will commonly be involved in surds, which it is impossible to exhibit on any arithmetical scale, and to which we can only make a repeated approximation. Hence the origin of that branch of analysis which is employed in the investigation of those problems, where the number of unknown quantities exceeds that of the proposed equations, but where the values are required in whole or fractional numbers. The subject is not merely an object of curiosity ; it can be applied with advantage to the higher calculus. Yet the doctrine of indeterminate equations has been seldom treated in a form equally systematic with the other parts of algebra. The solutions commonly given are devoid of uniformity, and often require a variety of assumptions. The object of this paper is to resolve the complicated expressions which we obtain in the solution of indeterminate problems, into simple equations, and to do so, without framing a number of assumptions, by help of a single principle, which, though extremely simple, admits of a very extensive application.

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LET $A \times B$ be any compound quantity equal to another, $C \times D$, and let m be any rational number assumed at pleasure; it is manifest that, taking equimultiples, $A \times mB = C \times mD$. If, therefore, we suppose, that $A = mD$, it must follow, that $mB = C$, or $B = \frac{C}{m}$. Thus two equations of a lower dimension are obtained. If these be capable of farther decomposition, we may assume the multiples n and p , and form four equations still more simple. By the repeated application of this principle, an higher equation, if it admit of divisors, will be resolved into those of the first order, the number of which will be one greater than that of the multiples assumed. Hence the number of simple equations into which a compound expression can be resolved, is equal to the sum of the exponents of the unknown quantities in the highest term. Wherefore a problem can be solved by the application of this principle, only when the *aggregate sum*, formed by the addition of the exponents in the highest terms of the several equations proposed, is *at least* equal to the number of the unknown quantities, together with that of the assumed multiples.

WE shall illustrate the mode of applying our principle, in the solution of some of the more general and useful problems connected with this branch of analysis.

P R O B L E M I.

Let it be required to find two rational numbers, the difference of the squares of which shall be a given number.

LET the given number be the product of a and b ; then by hypothesis, $x^2 - y^2 = ab$; but these compound quantities admit of an easy resolution, for $(x+y)(x-y) = a \times b$. If therefore we suppose $x+y = ma$, we shall obtain $x-y = \frac{b}{m}$; where m is arbitrary,

bitrary, and if rational, x and y must also be rational. Transposing the first equation, $x = ma - y$, and reducing the second, $mx - my = b$, and transposing $mx = b + my$, and therefore,

$x = \frac{b+my}{m}$; whence by equality $\frac{b+my}{m} = ma - y$, and reducing,

$b + my = m^2a - my$, and transposing $2my = m^2a - b$, whence $y =$

$\frac{m^2a - b}{2m}$; but $x = ma - y$, consequently $x = \frac{m^2b + a}{2m}$. If $m = 1$;

then $x = \frac{b+a}{2}$, and $y = \frac{b-a}{2}$.

SUPPOSE it were required to find a number which, increased or diminished by 10, would produce squares. It is obvious, that the number may be denoted, either by $x^2 - 10$, or $y^2 + 10$; whence $x^2 - 10 = y^2 + 10$, and transposing $x^2 - y^2 = 5 \times 4$, and applying the above formulæ, $x = \frac{5m^2 + 4}{2m}$; if $m = 2$, then $x = 6$ and the required number 26.

PROBLEM II.

To find two numbers, the sum of the squares of which shall be equal to the sum of two given squares.

By hypothesis, $x^2 + y^2 = a^2 + b^2$, and transposing $x^2 - a^2 = b^2 - y^2$, and, by resolving into factors, $(x+a)(x-a) = (b+y)(b-y)$; whence, by substitution, $x+a = mb - my$, and $x-a = \frac{b+y}{m}$. Transposing the first equation, $x = mb - my - a$;

reducing the second, $mx - ma = b + y$, and transposing, $mx = ma + b + y$, and therefore $x = \frac{ma + b + y}{m}$; whence, $\frac{ma + b + y}{m} =$

$mb - my - a$, and $ma + b + y = m^2b - m^2y - ma$, and transposing

posing $m^2y + y = m^2b - 2ma - b$, that is, $y = \frac{m^2b - 2ma - b}{m^2 + 1}$. But $x = mb - my - a$, and substituting, $x = \frac{m^3a + 2mb - a}{m^2 + 1}$. Thus, if $a = 5$, and $b = 10$, and $m = 2$; then $y = \frac{4 \cdot 10 - 4 \cdot 5 - 10}{5} = 2$, and $x = \frac{4 \cdot 5 + 4 \cdot 10 - 5}{5} = 11$; but $(11)^2 + (2)^2 = 125 = (10)^2 + (5)^2$.

Cor. If $b = 0$, we shall obtain two squares, the sum of which shall be a given square. For $y = -\frac{2ma}{m^2 + 1}$, or $+\frac{2ma}{m^2 + 1}$, and $x = \frac{m^3a - a}{m^2 + 1}$. Thus, if $a = 10$, and $m = 2$, then $y = \frac{4 \cdot 10}{5} = 8$, and $x = \frac{4 \cdot 10 - 10}{5} = 6$, but $64 + 36 = 100$.

PROBLEM III.

To find two rational numbers, the squares of which, together with any given multiple of their product, shall be equal to a given square.

By hypothesis, $x^2 + y^2 + bxy = a^2$, and transposing $x^2 + bxy = a^2 - y^2$, and resolving into factors, $x(x + by) = (a + y)(a - y)$; whence, by assumption, $x + by = ma - my$, and $x = \frac{a + y}{m}$. Transposing the first equation, $x = ma - my - by$; consequently, $\frac{a + y}{m} = ma - my - by$, or $a + y = m^2a - m^2y - mby$, and again by transposing, $m^2y + mby + y = m^2a - a$; whence $y = \frac{m^2 - 1}{m^2 + mb + 1} \times a$. But $x = \frac{a + y}{m}$, wherefore $x = \frac{2m + b}{m^2 + mb + 1} \times a$.

SUPPOSE

SUPPOSE $a = 22$, $b = 3$, and $m = 2$, then $x = \frac{4+3}{4+6+1} \times 22 = 14$, and $y = \frac{4-1}{4+6+1} \times 22 = 6$. But $196+36+252 = 484 = (22)^2$.

Cor. IF $b = 1$, the hypothesis will be $x^2+y^2+xy = a^2$; and $x = \frac{2m+1}{m^2+m+1} \times a$, and $y = \frac{m^2-1}{m^2+m+1} \times a$. Thus, if $a = 13$, and $m = 3$, then $x = \frac{6+1}{9+3+1} \times 13 = 7$, and $y = \frac{9-1}{9+3+1} \times 13 = 8$. But $49+64+56 = 169 = (13)^2$.

PROBLEM IV.

To find two numbers, such, that each, increased by unit, shall be a square, and their sum, increased by unit, a given square.

LET the numbers be denoted by x^2-1 and y^2-1 , and the first condition will be observed. The last requires, that x^2-1+y^2-1+1 , or $x^2+y^2-1 = a^2$. By transposition, $x^2-1 = a^2-y^2$, and by resolution, $(x+1)(x-1) = (a+y)(a-y)$; whence $x+1 = ma-my$, and $mx-m = a+y$. Transposing the first equation, $x = ma-my-1$; and transposing the second, $mx = a+y+m$, and dividing, $x = \frac{a+y+m}{m}$, whence $\frac{a+y+m}{m} = ma-my-1$, and reducing, $a+y+m = m^2a-m^2y-m$, or $m^2y+y = m^2a-2m-a$, and therefore $y = \frac{m^2a-2m-a}{m^2+1}$. But $x = \frac{a+y+m}{m}$, whence $x = \frac{m^2+2ma-1}{m^2+1}$.

SUPPOSE

SUPPOSE $a = 8$, and $m = 2$, then $x = \frac{4+32-1}{4+1} = 7$, and
 $y = \frac{4 \cdot 8 - 4 - 8}{4+1} = 4$, and the numbers are 48 and 15; but
 $48+15+1 = 64 = (8)^2$.

PROBLEM V.

To find two squares which, diminished by unit, shall be in a given ratio.

By hypothesis, $a : b :: x^2 - 1 : y^2 - 1$; whence the equation,
 $ay^2 - a = bx^2 - b$, and by resolution, $(ay+a)(y-1) =$
 $(bx+b)(x-1)$; wherefore by assumption, $ay+a = mx-m$, and
 $my-m = bx+b$. Transposing the first, $ay = mx-m-a$, and

dividing $y = \frac{mx-m-a}{a}$. Transposing the second, $my =$

$bx+b+m$, and dividing, $y = \frac{bx+b+m}{m}$, wherefore, $\frac{mx-m-a}{a} =$

$\frac{bx+b+m}{m}$, and reducing $m^2x-m^2-ma = abx+ab+ma$, that

is, $m^2x - abx = m^2 + ab + 2ma$, and therefore, $x =$

$\frac{m^2+ab+2ma}{m^2-ab}$; but $y = \frac{bx+b+m}{m}$, consequently $y = \frac{m^2+ab+2mb}{m^2-ab}$.

SUPPOSE $a = 2$, $b = 3$, and $m = 3$; then $x = \frac{9+6+12}{9-6} = 9$,

and $y = \frac{9+6+18}{9-6} = 11$; but $2 : 3 :: 80 : 120$.

Cor. I. WHEN the numbers x and y are very great, it is obvious that the ratio of $x^2 - 1$ to $y^2 - 1$, will be nearly equal to that of x^2 to y^2 ; and consequently the ratio of $\sqrt{a}$ to $\sqrt{b}$ will be still more nearly equal to that of x to y . If a and b , besides,
be

be nearly equal, the approximation will be more accurate. Let $m = a$; then the denominator $m^2 - ab$ will be small, and therefore the fractions large; whence, by substitution,

$$\sqrt{a} : \sqrt{b} :: \frac{a^2 + ab + 2a^2}{a^2 - ab} : \frac{a^2 + ab + 2ab}{a^2 - ab} = 3a^2 + ab : 3ab + a^2 = 3a + b : 3b + a, \text{ nearly.}$$

Thus $\sqrt{49} : \sqrt{50} :: 197 : 199 :: 7 : 7 + \frac{14}{197}$, whence $\sqrt{50} = 7,07107$, true to the last place.

Cor. 2. LET $m = \frac{a+b}{2}$; then $m^2 - ab = \left(\frac{a+b}{2}\right)^2 - ab = \left(\frac{a-b}{2}\right)^2$,

which, when a and b are nearly equal, will be small, and by

substitution, $\sqrt{a} : \sqrt{b} :: \frac{\left(\frac{a+b}{2}\right)^2 + ab + a(a+b)}{\left(\frac{a+b}{2}\right)^2 - ab} : \frac{\left(\frac{a+b}{2}\right)^2 + ab + b(a+b)}{\left(\frac{a+b}{2}\right)^2 - ab}$, nearly;

hence, by proper reductions, $\sqrt{a} : \sqrt{b} :: 5a^2 + 10ab + b^2 : 5b^2 + 10ab + a^2$. This formula is more intricate than the former, but still more accurate. Thus, $\sqrt{9} : \sqrt{10} :: 405 + 900 + 100 : 500 + 900 + 81 = 1405 : 1481$, and $\sqrt{10} = 3,16209$, true to the last place.

PROBLEM VI.

Let it be required to find a number, such that, if given multiples of it be increased by given numbers, the product of the sums shall be a square.

LET $(ex+f)(gx+b) = y^2$; by assumption $ex+f = my$, and $gx+b = \frac{y}{m}$. Transposing the first equation, and dividing,

$$x = \frac{my-f}{e}. \text{ Reducing the second, } mgx+mb = y, \text{ and transposing}$$

fining and dividing, $x = \frac{y-mb}{mg}$; whence, $\frac{my-f}{e} = \frac{y-mb}{mg}$, and reducing, $m^2gy-mfg = ey-meb$, and transposing, $m^2gy-ey = mfg-meb$, and consequently, $y = \frac{mfg-meb}{m^2g-e}$. Also $x = \frac{y-mb}{mg} = \frac{f-m^2b}{m^2g-e}$.

SUPPOSE $(7x+6)(2x+1) = y^2$. If $m = 2$, then $x = \frac{6-4}{8-7} = 2$, and $y = \frac{24-14}{8-7} = 10$; but $20 \times 5 = 100 = (10)^2$.

Cor. LET $e = 1$, and $g = 1$; the hypothesis will become $(x+f)(x+b) = y^2$. In this case, we obtain $x = \frac{f-m^2b}{m^2-1}$, and $y = \frac{mf-mb}{m^2-1}$. Thus, if $(x+12)(x+2)$, where $f = 12$, and $b = 2$,

and $m = \frac{3}{2}$; then $x = \frac{12-\frac{18}{4}}{\frac{9}{4}-1} = 6$, and $y = \frac{\frac{3}{2} \cdot 10}{\frac{9}{4}-1} = 12$; but $18 \times 8 = 144 = (12)^2$.

PROBLEM VII.

Let it be required to find rational values of x and y , in the general quadratic, $Ax^2+Bx+C = y^2$.

CASE I. *When the first term is a square.*

SUPPOSE $A = a^2$, when the expression becomes $a^2x^2+bx+c = y^2$; by transposition, $bx+c = y^2-a^2x^2$, and resolving into factors, $b(x+\frac{c}{b}) = (y+ax)(y-ax)$; whence, by assumption,

$x +$

$x + \frac{c}{b} = my - max$, and $b = \frac{y+ax}{m}$. Reducing the first equa-

tion, $bx+c = mby-max$, and $y = \frac{max+bx+c}{mb}$. Again, redu-

cing the second, $mb = y+ax$, and $y = mb-ax$; consequently,

$$\frac{max+bx+c}{mb} = mb-ax, \text{ or } max+bx+c = m^2b^2-max, \text{ and}$$

therefore, $x = \frac{m^2b^2-c}{2mab+b}$. But $y = mb-ax$; therefore, $y =$

$$\frac{m^3ab^2+mb^2+ac}{2mab+b}.$$

SUPPOSE $9x^2+7x+14 = y^2$, and $m = 2$; then $x = \frac{4.49-14}{4.21+7} = 2$, and $y = \frac{4.147+2.49+42}{4.21+7} = 8$; but $9.4+7.2+14 = 64 = (8)^2$.

Cor. 1. LET $a = 1$, the expression becomes $x^2+bx+c = y^2$; and $x = \frac{m^2b^2-c}{2mb+b}$, and $y = \frac{m^3b^2+mb^2+c}{2mb+b}$. Thus, if x^2+4x+4

$= y^2$, and $m = 2$; then $x = \frac{64-4}{16+4} = 3$, and $y = \frac{64+32+4}{16+4} = 5$; but $9+4.3+4 = 25 = (5)^2$.

Cor. 2. WHEN the third term is wanting, the expression becomes $a^2x^2+bx = y^2$; and in this case, the formulæ will become by reduction, $x = \frac{m^2b}{2ma+1}$, and $y = \frac{m^2ab+mb}{2ma+1}$. Thus, if

$9x^2+13x = y^2$, and $m = 2$; then $x = \frac{5^2}{4.3+1} = 4$, and $y = \frac{4.39+2.13}{4.3+1} = 14$; but $9.16+4.13 = 196 = (14)^2$.

CASE II. When the third term is a square.

SUPPOSE $C = c^2$, and the expression is $ax^2 + bx + c^2 = y^2$. By transposition, $ax^2 + bx = y^2 - c^2$, and by resolution, $(ax + b)x = (y + c)(y - c)$; whence by assumption, $x = \frac{y+c}{m}$, and $ax + b = my - mc$. But from the second equation, $x = \frac{my - mc - b}{a}$, consequently, $\frac{my - mc - b}{a} = \frac{y+c}{m}$; whence $y = \frac{m^2c + mb + ac}{m^2 - a}$, and $x = \frac{y+c}{m} = \frac{2mc + b}{m^2 - a}$.

SUPPOSE $3x^2 + 5x + 16 = y^2$, and $m = 2$; then $x = \frac{16+5}{4-3} = 21$, and $y = \frac{16+10+12}{4-3} = 38$. But $3 \cdot (21)^2 + 5 \cdot 21 + 16 = 1444 = (38)^2$.

Cor. 1. LET $b = 0$; then the expression becomes $ax^2 + c^2 = y^2$, and $x = \frac{2mc}{m^2 - a}$, and $y = \frac{m^2c + ac}{m^2 - a}$. Thus, $2x^2 + 9 = y^2$; if $m = 2$, $x = \frac{4 \cdot 3}{4-2} = 6$, and $y = \frac{4 \cdot 3 + 7 \cdot 3}{4-2} = 9$. But $2 \cdot (6)^2 + 9 = 81 = (9)^2$.

Cor. 2. IF $b = 0$, and $c = 1$; then $ax^2 + 1 = y^2$, and $x = \frac{2m}{m^2 - a}$, and $y = \frac{m^2 + a}{m^2 - a}$. Put $a = m^2 - d$, and we shall obtain $x = \frac{2m}{d}$, and $y = \frac{2m^2 - d}{d}$. Hence it is evident, that x and y will be expressed in whole numbers, when $2m$ is divisible by d . Call the quotient n ; then $x = n$, and $y = mn - 1$; whence $\frac{y}{x} = \frac{mn - 1}{n} = m - \frac{1}{n}$, or $m - \frac{d}{2m}$, which are the two first terms

of

of the *continued fraction* denoting $\sqrt{m^2-d}$, or $\sqrt{a}$. Thus, if $12x^2+1 = y^2$; then $\sqrt{12} = \sqrt{16-4} = 4 - \frac{1}{2} - \frac{1}{2} \&c.$ and

$x = 2$, and $y = 4 \cdot 2 - 1 = 7$; for $12 \cdot 4 + 1 = 49 = (7)^2$.

It is to be remarked, that, when $d = 1$, the values of x and y may be discovered from any given number of terms of the continued fraction.

Thus, if $3x^2+1 = y^2$; then $\sqrt{3} = \sqrt{4-1} = 2 - \frac{1}{4} - \frac{1}{4} \&c.$;

whence $x = 4, 15, 56, 209 \&c.$ and $y = 7, 26, 97, 362 \&c.$

If $a = m^2+d$, then $x = -n$, and $y = -mn-1$; but the expression $ax^2+1 = y^2$, will not be altered by changing the signs of x and y ; whence $x = n$, and $y = mn+1$; consequently, x and y will be determined from the continued fraction

denoting $\sqrt{m^2+d}$. Thus, $20x^2+1 = y^2$;
 $m + \frac{1}{n} + \frac{1}{n} + \&c.$

then $\sqrt{20} = \sqrt{16+4} = 4 + \frac{1}{2} + \frac{1}{2} \&c.$ and $x = 2$, and $y =$

$4 \cdot 2 + 1 = 9$; for $20 \cdot 4 + 1 = 81 = (9)^2$.

We may observe, that if $d = 1$, the values of x and y , in the expression $(m^2+1)x^2 \pm 1 = y^2$, may be found by taking an even or odd number of terms, according as the sign $+$ or $-$ is to be adopted.

Cor. 3. LET $c = 0$, then $ax^2+bx = y^2$; and, in this case,

$x = \frac{b}{m^2-a}$, and $y = \frac{mb}{m^2-a}$. Thus, $7x^2+4x = y^2$; if $m = 3$,

then $x = \frac{4}{9-7} = 2$, and $y = \frac{3 \cdot 4}{9-7} = 6$. For $7 \cdot (2)^2 + 4 \cdot 2 = 36 = (6)^2$.

CASE III. When $bb-4ac$ is a square.

LET $x^2 + \frac{b}{a}x + \frac{c}{a} = D \times E$; then the divisors of ax^2+bx+c will be $\frac{a}{n} \times D$, and $n \times E$. But it appears, from the doctrine of equations, that the excesses of x above the roots of the quadratic, $x^2 + \frac{b}{a}x + \frac{c}{a} = 0$, are the divisors of the expression $x^2 + \frac{b}{a}x + \frac{c}{a}$. Wherefore, $D = x + \frac{b+\sqrt{(b^2-4ac)}}{2a}$, and $E = x + \frac{b-\sqrt{(b^2-4ac)}}{2a}$. Hence, when $\sqrt{(b^2-4ac)}$ is a whole or fractional number, the expression ax^2+bx+c admits of resolution, and the divisors are $\frac{a}{n}(x + \frac{b+\sqrt{(b^2-4ac)}}{2a})$ and $n(x + \frac{b-\sqrt{(b^2-4ac)}}{2a})$. And when these are found, the solution will be obtained from Prob. VI.

SUPPOSE $14x^2+19x+6 = y^2$, then $b^2-4ac = 361-336 = 25$, and $D = \frac{14}{n}(x + \frac{19+5}{28})$, and $E = n(x + \frac{19-5}{28})$. If $n = 2$, the divisors will be $\frac{14}{2}(x + \frac{6}{7}) = 7x+6$, and $2(x + \frac{1}{2}) = 2x+1$; whence, from Prob. VI. $x = 2$, and $y = 10$. For $14.4+19.2+6 = 100 = (10)^2$.

CASE IV. When the general quadratic can be resolved into factors, if diminished by a given square.

LET $(ex+f)(gx+b) = y^2-d^2$, then $(ex+f)(gx+b) = (y+d)(y-d)$; whence $ex+f = my-md$, and $gx+b = \frac{y+d}{m}$.

By

By reducing the first equation, $x = \frac{my-md-f}{e}$; and by reducing the second, $x = \frac{y+d-mb}{mg}$; whence $\frac{my-md-f}{e} = \frac{y+d-mb}{mg}$, and consequently, $y = \frac{m^2dg+mfge+de-meb}{m^2g-e}$. But $x = \frac{my-md-f}{e}$, therefore also $x = \frac{2md-m^2b+f}{m^2g-e}$.

SUPPOSE $14x^2+31x+24 = y^2$; then, taking $9 = d^2$ from both sides, $14x^2+31x+15 = y^2-d^2$; but $\sqrt{(b^2-4ac)} = \sqrt{(961-840)} = 11$; whence, if $n = 2$, the divisors, by Case III. will be $7x+5$ and $2x+3$; wherefore, making $m = 2$, $x = \frac{12-12+5}{8-7} = 5$, and $y = \frac{24+20+21-12}{8-7} = 23$. For $14.25+31.5+24 = 529 = (23)^2$.

PROBLEM VIII.

Let c and d be known values of x and y in the expression, $ax^2+b = y^2$, and from these let it be required to discover others.

SINCE $ax^2+b = y^2$, and $ac^2+b = d^2$, subtracting these equations, we shall obtain $ax^2-ac^2 = y^2-d^2$, and by resolution, $(ax-ac)(x+c) = (y+d)(y-d)$; whence $ax-ac = my-md$, and $x+c = \frac{y+d}{m}$. From the first of these equations, $x = \frac{my-md+ac}{a}$, and from the second, $x = \frac{y+d-mc}{m}$; whence $\frac{my-md+ac}{a} = \frac{y+d-mc}{m}$, and $y = \frac{m^2d+ad-2mac}{m^2-a}$, or $\frac{(m^2+a)d-2mac}{m^2-a}$. But $x =$

$= \frac{y+d}{m} - c$; therefore $x = \frac{2md - (m^2 + a)c}{m^2 - a}$. To simplify these

formulæ, put $p = \frac{m^2 + a}{m^2 - a}$, and $q = \frac{2m}{m^2 - a}$; then will $x = dq - cp$, and $y = pd - qac$. If c become negative, the conditions of the problem will not be affected. In this case, $x = pc + qd$, and $y = pd + aqc$. The values of x and y , obtained from either of these formulæ, may be repeatedly substituted for those of c and d ; and thus a variety of numbers will be discovered.

SUPPOSE $2x^2 + 7 = y^2$, then $c = 1$, and $d = 3$; and if $m = 2$, $p = \frac{4+2}{4-2} = 3$, and $q = \frac{4}{4-2} = 2$; whence $x = 3 \cdot 1 + 2 \cdot 3 = 9$ or 3 , and $y = 3 \cdot 3 + 4 = 13$ or 5 . Again, $x = 3 \cdot 9 + 2 \cdot 13 = 53$ or 1 , and $y = 3 \cdot 13 + 4 \cdot 9 = 75$ or 3 . Or $x = 3 \cdot 3 + 2 \cdot 5 = 19$ or 1 , and $y = 3 \cdot 5 + 4 \cdot 3 = 27$ or 3 ; and so repeatedly.

WE may observe, that the value of p is the same with that of y in Prob. VI. Cor. II. and the value of q the same with that of x . Whence, if $p = d$, and $q = c$, we shall obtain for the expression $ax^2 - 1 = y^2$, $x = 2cd$, and $y = d^2 + ac^2$. Thus, in the example, $2x^2 - 1 = y^2$, where $c = 2$, and $d = 3$, $x = 2 \cdot 2 \cdot 3 = 12$, and $y = 3 \cdot 3 + 2 \cdot 2 \cdot 2 = 17$; and again, $x = 2 \cdot 12 \cdot 17 = 408$, and $y = 17 \cdot 17 + 2 \cdot 12 \cdot 12 = 577$.

PROBLEM IX.

To find two rational numbers, the sum of which shall be equal to a given number, and the sum of their squares a square.

By hypothesis, $x + y = a$, and $x^2 + y^2 = z^2$. Transposing the second equation, $x^2 = z^2 - y^2$, and resolving into factors, $x \times x =$

$= (z+y)(z-y)$; whence, $x = mz - my$, and $z+y = mx$; wherefore $mz = my+x$, and $z = \frac{my+x}{m}$; also, $z = mx-y$; conse-

quently, $my+x = m^2x-my$, and $y = \frac{m^2x-x}{2m}$. But from the

first equation, $y = a-x$; wherefore $a-x = \frac{m^2x-x}{2m}$, and $x =$

$$\frac{2m}{m^2+2m-1} \times a; \text{ consequently, } y = \frac{m^2-1}{m^2+2m-1}, \text{ and } z =$$

$$\frac{m^2+1}{m^2+2m-1} \times a.$$

SUPPOSE $a = 23$, and $m = 4$; then $x = 8$, $y = 15$, and $z = 17$. For $8+15 = 23$, and $64+225 = 289 = (17)^2$.

PROBLEM X.

To find two numbers, whose sum shall be a given number, and the product of the sums, formed by adding given numbers to them, a square.

By hypothesis, $x+y = a$, and $(x+b)(y+c) = z^2$. From the second equation, we obtain by assumption, $x+b =$

mz , and $z = \frac{x+b}{m} = my+mc$; and

so $x = m^2y+m^2c-b$. But, from the first equation, $x = a-y$;

consequently, $m^2y+m^2c-b = a-y$, and $y = \frac{a+b-mc^2}{m^2+1}$; also x

$$= a-y = \frac{am^2+mc^2-b}{m^2+1}, \text{ and } z = \frac{x+b}{m} = \frac{am+c^2+bm}{m^2+1}.$$

SUPPOSE

SUPPOSE $a = 17$, $b = 6$, $c = 2$, and let $m = 2$; then $y = \frac{17+6-8}{4+1} = 3$, $x = \frac{68+8-6}{4+1} = 14$, and $z = \frac{34+4+12}{4+1} = 10$.

But $14+3 = 17$, and $(14+6)(3+2) = 100 = (10)^2$.

PROBLEM XI.

Let it be required to find two numbers, such that, if to each, their sum and difference, unit be added, the numbers resulting shall be squares.

THE first condition will be observed, if the numbers be denoted by x^2-1 and y^2-1 . The hypothesis will then require $x^2+y^2-1 = z^2$, and $x^2-y^2+1 = v^2$.

TRANSPOSING the first equation, $x^2-1 = z^2-y^2$, and resolving into factors, $(x+1)(x-1) = (z+y)(z-y)$; whence, $v+1 = mz-my$, and $z+y = mx-m$; therefore, $z = mx-m-y = \frac{my+x+1}{m}$, from which we have $y = \frac{m^2x-x-m^2-1}{2m}$.

AGAIN, transposing the second equation, $x^2-y^2 = v^2-1$, and resolving, $(x+y)(x-y) = (v+1)(v-1)$, and by assumption, $x+y = pv-p$, and $v+1 = px-py$, and therefore, $v = \frac{px-py-1}{p}$. Hence $y = \frac{p^2x-x-2p}{p^2+1}$.

BUT it was found, that $y = \frac{m^2x-x-m^2-1}{2m}$; wherefore,

$$\frac{p^2x-x-2p}{p^2+1} = \frac{m^2x-x-m^2-1}{2m}; \text{ and by reduction, } x =$$

$$= \frac{p^2 m^2 + p^2 - 4mp + m^2 + 1}{p^2 m^2 - 2mp^2 - p^2 + m^2 + 2m - 1}, \text{ or } = \frac{(m^2 + 1)(p^2 + 1) - 4mp}{p^2((m-1)^2 - 2) + (m+1)^2 - 2}.$$

IN the same manner, by finding the values of x in terms of y , &c. we obtain $y = \frac{m^2 p^2 - 2m^2 p + p^2 - m^2 + 2p - 1}{p^2 m^2 - 2mp^2 - p^2 + m^2 + 2m - 1}$, or $= \frac{m^2((p-1)^2 - 2) + (p+1)^2 - 2}{p^2((m-1)^2 - 2) + (m+1)^2 - 2}.$

PROBLEM XII.

To find three numbers, the product of any two of which, increased by unit, shall be a square.

By hypothesis, $xy+1 = v^2$, $xz+1 = s^2$, and $yz+1 = w^2$.

1. TRANSPOSING the first equation, $xy = v^2 - 1$, and resolving, $x \times y = (v+1)(v-1)$, whence $y = mv - m$, and $v+1 = mx$; consequently, $v = \frac{m+y}{m} = mx - 1$, and $x = \frac{2m+y}{m^2}$.

2. AGAIN, transposing the second equation, $xz = s^2 - 1$, and resolving, $x \times z = (s+1)(s-1)$; whence, $z = ps - p$, and $s+1 = px$; consequently, $s = \frac{z+p}{p} = px - 1$, and reducing, $x = \frac{z+2p}{p^2}$. But $x = \frac{2m+y}{m^2}$; wherefore $m^2 z + 2m^2 p =$

$$2mp^2 + p^2 y, \text{ and } y = \frac{m^2 z + 2m^2 p - 2mp^2}{p^2}.$$

3. MOREOVER, by the third equation, $yz = w^2 - 1$; whence, $y \times z = (w+1)(w-1)$, and $y = qw - q$, and $w+1 = qz$; wherefore, $w = \frac{y+q}{q} = qz - 1$, and $y = q^2 z - 2q$.

But $y = \frac{m^2z + 2m^2p - 2mp^2}{p^2}$; consequently, $p^2q^2z - 2p^2q =$

$m^2z + 2m^2p - 2mp^2$, and $z = \frac{2p^2q + 2m^2p - 2mp^2}{p^2q^2 - m^2}$. Now, $y =$

$q^2z - 2q$; whence by substitution, $y = \frac{2m^2pq^3 - 2mp^2q^2 + 2m^2q}{p^2q^2 - m^2}$.

And because $x = \frac{2m+y}{m^2}$, we have also $x = \frac{2pq^2 - 2m + 2q}{p^2q^2 - m^2}$.

Cor. LET $m = 1$, then the formulæ will be more simple;

$x = \frac{2pq^2 + 2q - 2}{p^2q^2 - 1}$, $y = \frac{2pq^2 - 2p^2q^2 + 2q}{p^2q^2 - 1}$, and $z = \frac{2p^2q + 2p - 2p^2}{p^2q^2 - 1}$.

THERE is a remarkable case in which the above formulæ do not directly apply, the numerators and denominators vanishing at the same time. It is when $m = 1$, $p = 2$, and $q = \frac{1}{2}$. For,

by art. 3. $y = \frac{2m^2pq^2 - 2mp^2q^2 + 2m^2q}{p^2q^2 - m^2} = \frac{1 - 2 + 1}{1 - 1} = \frac{0}{0}$; where-

fore the value of y may be expressed by any assumed number, n .

But, by art. 1. $x = \frac{2m+y}{m^2} = y + 2$; whence $x = n + 2$. Also,

by art. 2. $x = \frac{z + 2p}{p^2} = \frac{z + 4}{4}$; therefore $z + 4 = 4n + 8$, and

$z = 4n + 4$. Thus, 2, 4, 12; for $2 \times 4 + 1 = 9$, $2 \times 12 + 1 = 25$, and $4 \times 12 + 1 = 49$.

PROBLEM XIII.

To find a cube which shall be equal to the product of a square by a given number.

By hypothesis, $x^3 = ay^2$, and resolving, $x \times x^2 = a \times y^2$; whence $x = ma$, and $y^2 = mx^2$; but $x^2 = (ma)^2$, consequently,

$y^2 = m^3 a^2$, and $y \times y = ma \times m^2 a$; and by a second assumption, $y = pma$, and $m^2 a = py$; but $x = ma$; whence $y = px$, and since $y = \frac{m^2 a}{p}$, $y = \frac{x^2}{ap}$; wherefore $\frac{x^2}{ap} = px$, and $x = ap^2$; but $y = px$, whence $y = ap^3$.

SUPPOSE $a = 3$, and $p = 2$, then $x = 3 \times (2)^2 = 12$, and $y = 3 \cdot (2)^3 = 24$. For $(12)^3 = 1728 = 3 \cdot (24)^2$.

PROBLEM XIV.

To find two numbers, the sum of which shall be a given square, and the sum of their cubes a square.

By hypothesis, $x + y = a^2$, and $x^3 + y^3 = z^2$. Dividing the second equation by the first, we obtain $\frac{z^2}{a^2} = x^2 - xy + y^2$, or

$$\frac{z^2}{a^2} - y^2 = x^2 - xy, \text{ and resolving into factors, } \left(\frac{z}{a} + y\right) \left(\frac{z}{a} - y\right) =$$

$$x(x - y); \text{ whence, } x = m\left(\frac{z}{a} - y\right), \text{ and } \frac{z}{a} + y = m(x - y). \text{ By}$$

$$\text{reducing the first of these expressions, } z = \frac{ax + may}{m}; \text{ and by}$$

$$\text{the second, } z = max - may - ay; \text{ whence } \frac{ax + may}{m} =$$

$$max - may - ay, \text{ and } y = \frac{m^2 x - x}{m^2 + 2m}. \text{ But from the first equation,}$$

$$y = a^2 - x; \text{ wherefore, } \frac{m^2 x - x}{m^2 + 2m} = a^2 - x, \text{ and therefore } x =$$

$$a^2 \times \frac{m^2 + 2m}{2m^2 + 2m - 1}. \text{ But } y = a^2 - x, \text{ consequently, } y = a^2 \times \frac{m^2 - 1}{2m^2 + 2m - 1}.$$

d d 2.

Also,

Also, because $z = \frac{ax+may}{m}$, we have by substitution, $z =$

$$a^3 \times \frac{m^2+m+1}{2m^2+2m-1}.$$

Cor. 1. If $a = 2m^2+2m-1$, two whole numbers may be always found, the sum of which, and that of their cubes, shall be squares. For in this case, $x = (2m^2+2m-1)(m^2+2m)$, $y = (2m^2+2m-1)(m^2-1)$, and $z = (2m^2+2m-1)^2(m^2+m+1)$.

Thus, if $m = 2$, we shall find $x = 88$, $y = 33$, and $z = 847$. But $88+33 = 121 = (11)^2$, and $(88)^3 + (33)^3 = 717409 = (847)^2$.

Cor. 2. If y be negative, we shall obtain two numbers, the difference of which, and that of their cubes, shall be squares.

Put $m = \frac{p}{q}$, and substituting, $x = a^2 \times \frac{\frac{p^2}{q^2} + \frac{2p}{q}}{\frac{2p^2}{q^2} + \frac{2p}{q} - 1}$, $y =$

$-a^2 \times \frac{\frac{p^2}{q^2} - 1}{\frac{2p^2}{q^2} + \frac{2p}{q} - 1}$, and $z = a^3 \times \frac{\frac{p^2}{q^2} + \frac{p}{q} + 1}{\frac{2p^2}{q^2} + \frac{2p}{q} - 1}$, and by re-

duction, $x = a^2 \times \frac{p^2+2pq}{2p^2+2pq-q^2}$, $y = a^2 \times \frac{q^2-p^2}{2p^2+2pq-q^2}$, and $z =$

$a^3 \times \frac{p^2+pq+q^2}{2p^2+2pq-q^2}$. If $a = 2p^2+2pq-q^2$, we shall obtain

whole numbers; for $x = (2p^2+2pq-q^2)(p^2+2pq)$, $y = (2p^2+2pq-q^2)(q^2-p^2)$, and $z = (2p^2+2pq-q^2)^2(p^2+pq+q^2)$.

THESE examples will probably be thought sufficient to explain the application of this method to the solution of indeterminate problems in general, and to shew that it is not less extensive, and much more uniform, than those that are commonly in use.

XV. *A DISSERTATION on the CLIMATE of RUSSIA.*
By MATTHEW GUTHRIE, M. D. *Physician to the Imperial Corps of Noble Cadets at St Petersburg, F. R. SS. LOND.*
and EDIN.: *With two LETTERS from his Excellency*
M. ÆPINUS, Counf. of State, Kn^t. of the Order of
St. ANNE, &c. &c. &c.

[*Read by Mr ROBISON, Nov. 2. 1789.*]

IN a paper published in the second volume of the second decade of the Medical Commentaries of Edinburgh, I mentioned a design of endeavouring to trace the influence of a cold climate on the human body and its diseases, which should form a contrast with the many accounts published of late years relative to the effects of hot climates ; and I likewise mentioned my having given a detached piece*, some years ago, as a commencement of the subject, in the sixty-eighth volume of the Philosophical Transactions of London, which contains matter necessary to illustrate some parts of the following Dissertation.

I WAS induced to this design, by having met with nothing of the kind in the course of my reading ; and by remarking that, whilst warm countries seem to occupy the attention of many of the Faculty, the more northern regions appear to interest but very few of our learned brethren, although it is but natural to conclude that if one extreme of temperature is found to have much influence, the other can scarcely be entirely without it.

IN

* THE title of the Dissertation mentioned above, is, *The Antiseptic Regimen of the Natives of Russia.*

IN this point of view, the subject seems to me to merit investigation, since the discussion of it is an object to science in general, and to medicine in particular. The plan, then, that I have chalked out to myself, as likely to throw light on the subject, is to give the History of the Northern Climate in one paper, and that of its Physical Influence in another, as it appears in the new capital of Russia, St Petersburg, where I have resided for many years. These two Dissertations will contain a number of facts and observations, from which Physicians, in the double sense of the word, may draw conclusions; for I pretend to nothing more than the honour of laying the foundation of an important work to be prosecuted by others, and which will probably require many years to complete.

As to the execution of my plan: *First*, I have made use of the meteorological register, kept in the Imperial Academy of Sciences, as such register must be more closely attended to than that of any individual, whose private business must often call him abroad at the proper hours of observation.

2dly, I HAVE adopted the Academy's division of the year into two seasons only, as in fact we have but two, properly speaking, *viz.* winter and summer, the one season running into the other, without leaving well defined intermediate periods, to answer to what are called spring and autumn in the temperate climates. Nature appears to hurry in the north, by as quick a transition as possible, from the long severe winter into its short but ardent summer; so that our thawing season occupies the period of your spring: and the same kind parent seems to prolong the season of vegetation, from a similar wise intention, as long as possible, till surprised in a manner at once by the return of winter, without much of what may be called autumn weather.

3dly, I HAVE followed the plan of the academic register, in prefixing to each season an enumeration of the common phenomena which take place in it, such as the quantity and duration
of

of frost, snow, rain, congelation, &c. as will be seen in the paper, adding to the short note of the Academy on each article, a few remarks of my own, which I have collected during a long residence in the north.

4thly, My calculations are all taken from the mean of fifteen years, as will be seen by the annexed register, an abridgment of that kept by Professor EULER, perpetual Secretary to the Imperial Academy of Sciences, with which he obligingly furnished me.

I AM happy to embrace this opportunity of acknowledging a number of similar obligations for many years past, from our equally liberal and learned Professors of the Imperial Academy of Sciences.

Lastly, I HAVE added to the register the comparative degrees of FAHRENHEIT and REAUMUR's thermometers, that answer to the given number of DE LISLE's scale, because the first is in common use in Great Britain, and the second in Russia, as it ought to be (and I believe generally is) with the public every where from its greater simplicity.

The RUSSIAN WINTER,

With the common Phenomena attending it.

THE Russian winter certainly must take the lead, when treating of the seasons, both from its duration and consequences in this northern situation. The duration of winter is generally from the end of September to the beginning of May, although we certainly have occasionally very pleasant weather in April, in spite of morning and evening frost, which the sun, in his nearer approach, dissipates instantly on appearing above the horizon; nay, the agreeable effect which a little of his sensible influence has, when contrasted with his little more than lunar action for so long a period, leads us to give to April almost the rank of a summer month, although I doubt if, in a more southern

fouthern country, it would merit that appellation under the same circumstances.

Duration of Frost and Snow.

THE duration of winter, if it is to be defined by the mean term of frost and snow, according to the common method, must be dated from the 9th of October to the beginning of May, when its force is so far spent as to be perceptible only by a flight hoar-frost at an early morning hour; and as the continuance of snow is generally much the same as that of frost, we may reckon the mean period of both at about 230 days in the year.

Term of the Rivers remaining Frozen.

BUT the duration of what is called the real Russian winter, when our communication by water with the rest of the world is shut up, and that element confounded in appearance, and almost in solidity, with the land, is considerably shorter, and is to be reckoned from the 27th of November to the 19th of April, (its mean term for fifteen years past), that is to say, it comprehends about 160 days in the year; for in the season allotted to winter by the ordinary definition, as given above, there are about 70 days, when our frost, although equal to the congelation of water in its tranquil state, is incapable to arrest the rapid current of rivers. Nay, I am yet to learn what degree of it might be required for that purpose; for in this country there are certain circumstances which usually accelerate the congelation of rapid rivers, such as, their surface being covered with floating ice, formed in the lakes * above, which,
at

* As for example, the floating ice which covers the Neva, and so much facilitates its congelation, is formed in the Ladoga lake, where an inferior degree of frost can act upon the still water, to what is necessary to congeal the river, and on the first wind it is broke up and carried down by the current.

at the first obstacle it meets with in its course down the river, (as at the bar a little below the city of Petersburg) accumulates so as to form one uniform sheet to appearance, for many miles above the obstacle, composed of a number of large thick flakes, which the severe frost that commonly prevails about that time, almost instantly cements together, although the same degree of frost is much inadequate to the power of congealing the naked surface of the running river. By this œconomy of nature, although the northern countries are much intersected by large and rapid rivers, which, from the floating ice, do not admit of standing bridges, still the communication is seldom interrupted for twenty-four hours, as they shut up with a degree of thickness sufficient to bear the weight of a man almost immediately, and heavy burdens in a few days.

Thickness and other Phenomena of the Ice.

By February, our ice has acquired the astonishing thickness of about three quarters of an English yard, and, what is equally astonishing, it has lost not above a third of it, when become so weak, at the breaking up of the rivers, as not to support the weight of a dog. At this period, I have paid particular attention to its appearances, and found the mass composed of a number of long solid crystals, resembling, in some measure, the pipes of an organ, about half a yard long, but almost without adhesion, so that the mass seems to have lost little but the cementing principle, (if I may be allowed the expression) which bound those crystals together; instead of its being reduced, according to the common opinion, to a pellicle, by the action of the sun and water on its upper and under surfaces, which any one may convince himself is a vulgar prejudice, by simple inspection of a piece of the floating ice on the breaking up of the Neva, which, although sunk so deep in the water as

to appear only like a pellicle above the surface, has the considerable thickness that I have mentioned, concealed below the water.

I MAY here subjoin some observations on the conducting power of ice with respect to sound. This is affirmed to be very great, by the ingenious Professor of Natural Philosophy in your University*. I am disposed to accede to his opinion, from knowing, that even the unbroken and uncultivated ground of our stepps or deserts conducts sound so well, that the Cossacks hear the tread of a horse at a great distance, by laying their ear to the ground. Experiments might be tried in this country on a very great scale. But as I have not had an opportunity of this kind since the thought struck me, I shall content myself with giving the following extract of a letter from a friend: “ Having walked out on the ice to a great distance from our fort “ the other day, when its cannon were discharged for the taking “ of Oxakow, the first intimation I received of this event “ was, by a disagreeable ringing sound from the ice, and, after “ some seconds, the usual report through the air, but not so “ violent as the first.”

Register of the Weather for the six Winter Months.

T H E R M O M E T E R.

OUR greatest cold exceeds in general 196° of DE I SLE's, equal to 24° below 0 of FAHR. or $24^{\circ}\frac{1}{2}$ of REAUM. below 0, and commonly obtains in January.

OUR mean cold for the six winter months is, in the afternoon, 154° , equal to 27° of FAHR. above 0, or equal to 2° of REAUM. below 0; Night, 162° , equal to 23° of FAHR. above 0, or to 7° of REAUM. below 0.

IT must always be remembered, that they are the mean degrees of cold and heat during a period of fifteen years, which are

* JOHN ROBISON, M. A. Professor of Natural Philosophy in the University of Edinburgh.

are set down in this register ; for we have often, for example, a more considerable degree of cold than what is indicated above, as our greatest during the season ; 27° of REAUM. or 62° of FAHR. below 0, are often felt here, and sometimes as far as 30° ; nay, a cold of 32° below the freezing point of REAUM. is upon record, which is the freezing point of the purest mercury, according to my experiments, published here in 1785.

It must be also remarked, that the thermometer sometimes has a surprising range during winter, so as to produce a change of temperature from 10° to 25° of REAUM. (or from 23° to 57° of FAHR.) in 24 hours ; a trying circumstance for delicate constitutions, and which the most robust feel after the prime of life. The pressure of the air on the body is also equally variable in 24 hours, as indicated by the barometer on these occasions.

B A R O M E T E R.

Placed 20 feet above the mean level of the Neva, and at 6000 from its opening into the gulph of Finland.

Highest,	28.87	oftenest in January.
Lowest,	26.99	oftenest in November.

Difference, 1.88

Mean height, 28.02 Paris inches.

Winds.

THE prevailing wind during winter is the west, and its proportion to the east is,

West, 113 days in the six winter months.

East, 68 days in the same period.

N.B. THE south wind, and all to the west of the meridian, is reckoned west ; the north wind, and all to the east of the meridian, is reckoned east.

THIS circumstance of the west and southerly winds prevailing during the severe northern winter, must appear rather singular to most people, especially in Great Britain, where the very name of N. and N. E. winds conveys the idea of cold. But this phenomenon may easily be explained on the principles advanced by Professor ROBISON, in the Notes to Dr ROBERTSON'S History of America. *Vide* Note 4. B. IV.

Mean Quantity of melted Snow and Rain.

THESE together do not amount, in the six winter months, to more than about five Paris inches, although the whole surface of the northern countries is covered with snow to a considerable depth, over which we drive in sledges, without distinguishing between land and water; whilst, during summer, a period apparently fair in comparison, there falls more than double the quantity of rain; but indeed, as it pours in torrents, when it does rain, like thunder-showers in hot seasons, there must fall more than the apparent dryness of the season would lead one to suppose at first sight, especially when the large portion furnished by the heavy night-dews, is added to the quantity.

I MUST here observe, that water seems to acquire some new properties, from being converted into snow, frost, incrustations, and even common river ice, if we are to judge from the following facts: *First*, I have shewn, in a paper published in the Philosophical Transactions of London, that the frozen incrustation, which is formed on the inside of the windows, in the habitations of the lower class of people in this country, during the severe part of winter, (an inconvenience avoided in the better sort of houses by double windows), sets loose, on thawing, a species of mephitic air, producing all the dangerous effects of the fumes of charcoal on people exposed to its action.

2dly,

2dly, A Mr SCHROETER of this city has found the water of these incrustations to be of a very volatile nature; and indeed the solutions of all the frigorific productions mentioned above, possess a superior disposition to evaporate to river water in its natural state, as is shown by the following experiment:

HE poured into five tea-cups, standing in the window of his room, a tea-spoonful of each of the five different fluids mentioned below, when, at the expiration of 24 hours, their comparative degrees of evaporation were as follow:

No. 1. A tea-spoonful of window crust water was almost all evaporated.

2. ————— hoar frost water had lost about the half.

3. ————— snow water had lost about a third.

4. ————— Neva ice water had lost rather less than a third.

5. ————— River Neva water had lost nothing to appearance.

Hail.

Its appearance is a rare phenomenon in this season: But I shall leave to the ingenious author of the Theory of Rain *, (in the first volume of the Transactions of the Royal Society of Edinburgh) to give a reason why water should constantly take the form of snow during the severe weather of the north, and so seldom that of hail. Can it be that the sun has not sufficient influence, at this period of the year, to raise it to the higher region, where the form of hail is supposed to be given?

Tempests

ARE equally uncommon with hail in the season treated of. Indeed nature seems to have studied a perfect equality in the distribution of her favours, as it is only the parts of the earth which

* Dr JAMES HUTTON.

which most enjoy the kindly influence of the sun, that suffer by the effects of its superior heat ; so that if the atmosphere of the north is not so genial as that of the south, at least it remains perfectly quiet and serene, without threatening destruction to man and the product of his industry, as in what are commonly called happier climates.

Aurora Borealis.

As to the Aurora Borealis, it often illuminates our hemisphere, more particularly in winter, when it appears from sixteen to seventeen times in the six months, although we, by no means, enjoy so much of its light as our more northern neighbours, who have certainly a better title to its services, from the beautiful plan of equality mentioned above. Some remarks which I shall make in the next article but one, may probably strengthen the opinion of its being an electric phenomenon, that is to say, if proving the atmosphere in general to be uncommonly electric, at the time of its greatest prevalence, can lead to a presumption of its connection with that fluid.

Parheliums and Mock Moons

ARE seen pretty frequently in the north. Probably our frozen mists and vapours make these phenomena more frequent here than in the temperate climates.

General Observations on the Winter Atmosphere.

THE air, though cold, is remarkably pure and elastic during our severe frost, so as to give a most surprising degree of spring and tone to the human frame. At this time the atmosphere is most astonishingly electric, even more so than during our violent thunder-storms in summer, if we are to judge from the
great

great power of our electrical machines, and from several other phenomena too curious to be passed over in silence.

THE most striking of these is the appearance of a flame, on drawing a flannel cover off a silk chair, or on rubbing with a woolen cloth the silk hangings of an apartment. On this last operation, a flame was seen running along the gold-laced border, to the great amazement of the Imperial servants, to whom these alarming meteors appeared, on dusting the apartments of the palace in a dark winter morning, as I remember to have heard at the time, though many years ago. But the facts of this nature, which I got from our ingenious and learned electrician M. *ÆPINUS* *, whilst Preceptor to his Imperial Highness the Great Duke, are much more circumstantial and interesting. See his letter at the end.

HOWEVER, I do not mean to assert, that the total of the electric fluid contained in the atmosphere is greater in winter than summer, during the violent commotions it occasions here, which are sometimes of a very alarming and dangerous nature. I only say, that it appears to be more equally diffused through the whole volume of the atmosphere, from not being collected into clouds, as in summer, and that the air is in a state more disposed to part with it. In fact, no clouds are to be seen during severe frost, nor indeed can water exist in that form, but is divided into infinitely small particles, frozen into shining spicula, which play and sparkle in the beams of our bright though feeble sun, in a very beautiful manner. This appearance of something like brilliant points floating in our atmosphere,

* As it may operate to the encouragement of Science, permit me to inform the Society, that when this respectable Philosopher (so well known in Europe by his profound and ingenious writings on Electricity and Magnetism) had finished the education of his Imperial Highness the Grand Duke of Russia, he was advanced to the rank of actual Counsellor of State, with a pension to support his new dignity, and was decorated with the red ribbon of St ANNE, an order only bestowed on men of high military or civil rank. This anecdote shows how well the present Sovereign understands rewarding merit, when it falls under her immediate cognisance.

sphere, is not constant, but I think follows a sort of cloudiness, which occasionally takes place on a change of temperature, as if it was going to snow; but on the cold increasing a few degrees, which it does often very suddenly, the sky becomes instantly clear again, and seems to have acquired the little particles in question, which I have often thought I felt acting against my face, while driving with great velocity in a sledge.

THAT I may separate as much as possible theory from facts, I reserve to this place some explanation of what I have said above, and beg leave to hazard a conjecture, in form of a query, for those who have more leisure and genius than myself. It would indeed be difficult to reconcile the idea of our atmosphere possessing a greater quantity of electric fluid in winter than summer, with the discoveries of Messrs DE VOLTA and SAUSSURE, who have found the electricity of the air in dry weather to be constantly positive. The last mentioned gentleman supposes its positive state to be maintained by a regular supply of vapours from the earth, (which are discovered to abound with that fluid) carrying up a portion of the electricity that belongs to the globe. Now, as in the north the earth is hard frozen during winter, one should think the supply by evaporation cannot be so great in this season as in summer, and of course its positive state with difficulty kept up from this source, according to Dr FRANKLIN's Theory of Plus and Minus. Will that of two distinct fluids (to which Mr SAUSSURE seems to lean in some part of his works) account for it better? There is a theory very prevalent in Germany and Sweden; nay, we even find the respectable names of BERGMAN, SCHEELÉ, WILKE, &c. amongst its advocates. This is a sufficient reason for my giving it a place in this paper, lest it should not be generally known in Britain.

POSITIVE electricity is supposed to be common air saturated with heat or fire, as they term it; negative electricity is supposed to be phlogiston, combined with an acid. As to the commotion,

commotion, they account for it, by supposing that it is owing to the air and phlogiston rushing with violence together, (from great affinity) and suddenly setting loose the heat contained in the air, according to CRAWFORD's theory, which then becomes sensible, and in some cases visible. I must take the liberty of suggesting a doubt if this new theory will account for so many phenomena in electricity, as the beautiful and simple one of FRANKLIN and ÆPINUS, particularly for Earl STANHOPE's returning stroke, which his Lordship proves to have been the death of Mr BRYDEN's carter and horses, in so satisfactory a manner, that no man in future will think himself safe in a thunder-storm, however distant from the explosions.

It might be supposed, from the severity of the frost mentioned above, that we suffer much cold during this period; but the fact is just the reverse: for people in easy circumstances, who are not obliged to remain much out of doors, but drive, or even walk from one house to another, suffer less than in most countries, as there reigns constantly a summer heat from 14° to 16° of REAUMUR in our apartments, where flowers blow all the winter; and when out of doors, the warm fur dress, with the skin furniture of the sledges, (a coach requires none) keep the body so comfortable, that I am convinced less cold is felt (difference of dress considered) in driving through the streets of Petersburg in our cold dry air, than through those of London or Edinburgh, during the cold moist weather that obtains there during a great part of the winter; especially as this state of the atmosphere in Britain is often accompanied by bleak winds, whilst the air in Russia, during our greatest cold, is generally serene and calm. In fact, we have only the face to guard against the frost when out of doors, by occasionally raising the cape of our fur garb, as all the rest is secured against its attack by the well contrived dress of the north; and at home, if the door is only kept shut, the cold can enter from no other quarter, (the windows being double, well caulked and

papered in the seams) to counteract the equally diffused heat produced by well contrived stoves, which are built generally of white tiles, and admit of much latitude of elegant form.

THE above description of our mode of living in winter, accounts for a circumstance that has been regarded as affectation, both in the natives of Russia, and in foreigners who have resided long here, *viz.* their complaining of cold during winter in the temperate climates; for, on taking into consideration their mode of living at home, there is nothing more natural than their suffering cold in countries where neither the houses nor dresses are calculated to keep it from constantly acting on the body, during a certain period of the year. This is a situation quite new to a Russian, and which produces sensations more disagreeable than can easily be imagined, till custom makes it familiar, and that they have learned to seek heat in exercise, instead of ovens and furs; a lesson by no means unprofitable to people of fashion from the northern countries of Europe.

S P R I N G.

As to spring, I must again repeat my remark in the introduction, that we can hardly say that it exists here; the seasons of winter and summer running into one another, almost without any sensible intermediate one: For by the time that the immense mass of snow and ice, which covered the face of land and water, is melted, the sun has acquired so much influence, as to dart on us at once a summer heat. It is probable that the quantity of water produced by this operation, when joined to the effect of our heavy night dews in the hot weather, may render a wet intermediate season unnecessary, whilst the short period allowed to hurry vegetation through all its stages, will scarcely admit of it. Is it not possible, likewise, that the sudden commencement of summer on the finishing of the thawing process, may be accounted for, in some measure, by Dr BLACK'S
Theory

Theory of Latent Heat? For as water requires a great portion of sensible heat to resume its fluid form, of course, a large proportion of that furnished by the sun will be absorbed, until the whole is dissolved, when we at once receive all his influence, without any part of it being absorbed by our winter covering. When this cause is joined to the cold produced by the evaporation going on during the thawing period, it is easy to conceive how different our feelings must be at the time when they are both removed, and the earth is beginning to acquire and give out warmth; which very quickly takes place in this light sandy soil, that lets the water readily filter through it, and almost immediately begins to heat.

RUSSIAN SUMMER,

With the common Phenomena attending it.

OUR Russian summer, during a good season, presents exactly the opposite extreme to winter, the former being nearly as hot as the latter is cold; an admirable arrangement of nature, if we consider the task the sun has to perform, with regard to vegetation, during that short space of time. The influence of the sun during the period of a Russian summer, is no doubt aided by that equally wise œconomy relative to the habits of plants; for whilst the northern ones run their course uniformly in the short space of time allotted to them, (even in Iceland, where, from its insular situation, the heat cannot be so considerable as with us), those imported from the south can, by no means, effect all their stages of vegetation, within the bounds of a Russian summer, until they have passed a few seasons in this climate, and thus acquired the habits of the indigenous plants of the country.

It is remarkable, that the thermometer falls exactly to $24^{\circ}\frac{1}{2}$ of REAUMUR below the freezing point, during our greatest

ff 2

cold

cold in winter, and rises to the same number of degrees above it, during our greatest heat of summer, taking the mean of fifteen years. The sun's remaining so many hours above the horizon, or rather scarcely leaving it at all during a certain period of our summer, affords one reason for the violent heat which a traveller meets with, to his no small astonishment, in the latitude of 60, as the air and earth have not time to cool in the short interval between his setting and rising again. Two British travellers from Bengal, (where they are certainly accustomed to great heat) complain much of that of the present summer in St Petersburg.

I TAKE this opportunity of mentioning a curious fact connected with northern vegetation. There is a dish to be found at the tables of Moscow during winter, which will scarcely be credited by the rest of Europe, when it is remembered that the climate is nearly as severe as at Petersburg, *viz.* asparagus, reared in the open air, the production of a species of Russian gardening, which merits being known.

IN autumn, the asparagus beds are covered with mats, and buried by the falling snow, which is most abundant in this climate, so as to preserve the plants from being frozen, until they are wanted. When a bed of them is to be thrown into vegetation during winter, it is done by cutting a deep and broad trench all around it, down to the unfrozen earth, which is filled with smoking dung, taken out of the middle of a large dunghill; the old mats, covered with snow, are then removed, and dry ones put in their place, and upon them a thick layer of warm dung, leaving only small apertures for the plants to push through.

Register of the Weather for the six Summer Months.

T H E R M O M E T E R.

Greatest heat, 106° commonly in July or August, equal to 85° of FAHR. above 0, or to $24^{\circ}\frac{1}{2}$ of REAUM. above 0.

Least heat, 144° in May or October, equal to 41° of FAHR. above 0, or to 3° of REAUM. above 0.

Difference, 38° equal to $46^{\circ}\frac{1}{2}$ of FAHR. or equal to $20^{\circ}\frac{1}{2}$ of REAUM.

Mean heat of the aftern. 127° equal to 59° of FAHR. above 0, or equal 12° of REAUM. above 0.

Mean heat of the night, 136° equal to 49° of FAHR. above 0, or to $2^{\circ}\frac{1}{2}$ of REAUM. above 0.

Mean heat of the climate at large, $2^{\circ}\frac{7}{16}$.

B A R O M E T E R.

At highest, 28.42 oftenest in May.

At lowest, 27.50 oftenest in September.

.92 The middle between these extremes is 27.96.

Mean height, 28.04 Paris inches.

Winds.

THE wind that predominates here in summer, as in winter, is the west.

West wind, 110 days.

East wind, 84 days.

Rain.

Rain.

THE quantity of rain that falls in the six months, is $10\frac{22}{100}$, or about 11 Paris inches.

Rainy days,	80.
Tempest during this season,	from 11 to 12.
Showers of hail,	from 2 to 3.
Aurora Borealis,	from 8 to 9.
Fog,	17 days.

I SHOULD be happy in being able to give the heat of deep wells and springs in this province, to compare with the mean heat of our climate, which, according to a curious modern discovery, ought to be pretty nearly the same; but as our water lies within about four yards of the surface, at least in the district I inhabit, it may be supposed to be affected by the influence of the sun during summer, and the severe frost in winter. To avoid, then, as much as possible, both these causes of error, I have chosen for the time of my experiment, what, in my opinion, is the most favourable of the whole year, *viz.* the short interval which takes place between the rigorous season of winter and the heat of summer, when the water is most exempt from either influence. The epoch fixed upon then for my experiment was the 9th of May, whilst we had still a little floating ice in our river, the last of that which comes down from the lake Ladoga every spring on its breaking up. At this time, the trees were still without a leaf, except the birch, which was just budding; and REAUMUR's thermometer stood at $10^{\circ}\frac{1}{2}$ above the freezing point, some degrees higher than it had yet done; so that I think, from the small effect the sun had yet produced on vegetation, &c. we cannot well suppose, that the temperature of a thick covered well in my garden, excluded as much as possible from communication with the open air, by every precaution I could invent, could be so much affected by it, as to produce an error on the side of heat.

May

May 9. Heat of the air, $10^{\circ}\frac{1}{2}$ above 0.
 Heat of the well in my garden, Imp.
 Cadet Corps, $2^{\circ}\frac{3}{4}$ above 0.

Now, as the mean heat of our climate is $2^{\circ}\frac{7}{10}$, there is a very remarkable coincidence between it and the heat of the water, even taken under all the disadvantages mentioned above. However, I by no means offer this as the absolute and exact temperature of deep wells and springs in this province, which may certainly be considerably different.

THE mean heat of the only four countries determined in this manner, that have fallen under my cognifance, make a short but curious scale, as they are of temperate, torrid, and frigid climates. As for example:

		Mean heat of the climates.	Heat of wells and springs.
St Petersburg,	N. Lat. $59^{\circ} 26' 23''$ Long. $30^{\circ} 25'$ E. from the first merid. of Greenw.	$2^{\circ}\frac{7}{10}$	$2^{\circ}\frac{3}{4}$
London,	N. Lat. $51^{\circ} 31'$ Long. 0	$7^{\circ}\frac{3}{4}$	$7^{\circ}\frac{3}{4}$
Paris,	N. Lat. $48^{\circ} 50'$ Long. $2^{\circ} 25'$ E.	10°	$10^{\circ}\frac{1}{4}$ in the cave under the observatory.
Kingston, Jam.	N. Lat. $18^{\circ} 15'$ Long. $76^{\circ} 38'$ W.	$21^{\circ}\frac{3}{4}$	$21^{\circ}\frac{1}{4}$

THE difference of temperature between London and Paris is more remarkable than their distance will account for, and, of course, is an illustration of the effect of insular situation, which was my reason for setting down two places so near to one another. Accident sometimes presents us with one interesting fact when in search of another. This was my case, in taking the heat of the earth in my garden, to contrast with that of my well, for a particular purpose. On April 19. 1789, REAUMUR's thermometer at 7° above 0, I found the heat of the earth, in a soft bed one foot from the surface, only half a degree above the freezing point, and on the next day was astonished

nished to find it at 5° above it, although the thermometer in air had not altered its position, but was still at 7° , nor had the sun shone out in the interval, so that this surprising change of heat in the earth seems to have been effected by a shower of rain that fell between the two observations; a strong confirmation of the hypothesis that rain water contains a large portion of latent heat, and probably of electric matter; so that it is not surprising, if plants should, under certain circumstances, start, as it were, suddenly out of the earth after a shower of rain, as they receive so large a supply, not only of moisture, but likewise of heat, and possibly a vivifying principle from the stimulus of the electric fluid carried down by the rain.

General Observations on the Summer Atmosphere.

THE state of the atmosphere during the summer, is in general pretty fixed, and the air very serene and clear, both during the day and night, in spite of the heavy dew that falls from the setting to the rising of the sun, which seems to serve, as before observed, for watering the plants during this hot dry season. I have been much struck with observing, that an excellent hygrometer, sent me by the learned Professor PICTET of Geneva, (hung within doors with the windows open) indicated a greater degree of humidity, on a fine summer evening, than during the most continued rainy weather; so much higher is the saturation of the air with water, and so much greater is its diffusion through it, than when it falls in the form of rain. This observation favours the modern hypothesis of the chemical solution of water in air.

I THINK also worthy of remark, the much greater effect this sultry debilitating period has upon foreigners, (from even warm countries) than on the natives of the north, as one should naturally think the former would support it better, than a people unaccustomed, for so long a period of the year, to excessive

cessive cold. This, however, is by no means the case; for whilst foreigners can scarcely take any exercise out of doors, with the sun high above the horizon, without feeling a species of faintish debility, the natives even carry on the hardest labour without much apparent fatigue. This may probably be accounted for by their constant use of the vapour bath, heated to a degree unsupportable for many minutes to a foreigner, whilst they feel themselves perfectly at their ease in it, from habit, and are as fond of it as the Greeks and Romans were of the tepid water bath.

ANOTHER circumstance in the mode of life of this northern people, which may also contribute greatly to their supporting so well considerable degrees of heat, is their living at home, for eight months of the year, in a constant heat of from 16° to 20° of REAUM. or from 68° to about 77° of FAHR.; nay, even during the summer, the ovens of their cottages are obliged to be pretty constantly heated, each peasant baking his bread at home, and dressing his victuals in them.

A U T U M N.

THE remark I have already made on the seasons will account for my leaving this period blank, and only mentioning it for form's sake. I have annexed the abridged register of fifteen years, made use of in this paper, as there may be some who would wish to see it.

TWO LETTERS on ELECTRICAL and other PHENOMENA ;
addressed to Dr MATTHEW GUTHRIE, Conf. Aul. F. R. SS.
 LOND. and EDIN. *Physician to the Imperial Corps of Noble*
Cadets, and to that of the Artillery and Engineers in St Petersburg,
by his Excellency M. ÆPINUS.

[*Translation from the French.*]

DEAR SIR,

I ACKNOWLEDGE the pleasure I have received in perusing your paper on the Northern Climate ; and certainly it would be difficult to give, with more method and intelligence, a clear and distinct idea of the peculiarities of our climate, *quod malus Jupiter urget*, and which distinguish it from the other countries of Europe, placed under a more mild and temperate sky.

I SHALL therefore comply with pleasure, in giving a circumstantial account of the curious facts mentioned in your Dissertation, as seen and authenticated by me ; and shall, at the same time, avail myself of your permission to communicate the remarks and reflections I have made on reading your interesting Dissertation *.

THE uncommon phenomena alluded to in your paper, were as follow : During the last weeks of the year 1766 and the first of 1767, we had constantly very strong frost, with the
 calm,

* Dr GUTHRIE solicited the learned gentleman's remarks and opinion on his paper. M. ÆPINUS is the oldest Professor of the Imperial Academy now alive, having spent upwards of thirty years in this country ; and as Natural Philosophy was his professional line before called to Court, and his amusement since, his Excellency is of all others most able to judge of the peculiarities of our climate, and the fittest to put the stamp of veracity on this Dissertation, its principal merit.

calm, clear and serene sky which generally accompanies it in this climate; and during its prevalence, her Imperial Majesty having sent for me one morning, ordered me to go to the apartments of Prince ORLOFF, in another part of the palace, who, she said, had, for some days past, become uncommonly electric every time his hair was combed.

I FOUND the Prince at his toilet, and observed, in fact, that, at every time his valet de chambre drew the comb through his hair, a pretty strong crackling noise was heard; and on darkening the room, by drawing the curtains, the sparks were seen following the direction of the comb in great abundance, whilst the Prince, by this operation, was become so completely electric, that strong sparks could be drawn from his hands and face; nay, he was even electrified when he was only powdered with a puff, the friction of the air against his hair being able to produce a considerable degree of electricity; a curious experiment, which however but seldom succeeded afterwards, when I was desirous of repeating it.

A FEW days after this scene with the Prince, I was witness to a still more striking effect of the electric state of our atmosphere at this period. His Imperial Highness the Grand Duke sent for me one evening in the twilight, and told me, that, having briskly drawn a flannel cover off a green damask chair in his bed-chamber, which had been put on it by accident, he was astonished at the appearance of a strong bright flame that followed it; but having immediately comprehended that it must have been an electric phenomenon, his Highness had been trying to produce a similar illumination on different pieces of furniture, and could now show me a beautiful and surprising experiment, that he had just discovered.—His Highness then threw himself on his bed, which was covered with a damask quilt laced with gold, and rubbing it with his hands in all directions, the young Prince, who had then reached his twelfth year, appeared to be swimming in fire, as, at every stroke,

flames arose all around him, which, darting to the gold lace border, run along it, and up that of the bed, to the very top.

WHILST his Highness was showing me his experiment, Prince ORLOFF, who had been making many different trials of his personal electricity, since the day I saw him at his toilet, came into the room with a sable muff in his hand, and showed us, that, by only whirling it five or six times round his head in the air, he could electrify himself so strongly, as to send out sparks from all the uncovered parts of his body; another proof that the simple friction of air against hair could produce electricity. Similar experiments were repeated in many houses of the city, whilst the strong frost prevailed; which shows, that the uncommon disposition of bodies to electricity, during the period treated of, was general.

THESE curious phenomena have appeared from time to time since that epoch, particularly during the severe cold which has prevailed for these four weeks past. A few days ago, a lady of my acquaintance informed me, that, on having her head combed, not only her hair showed the ordinary signs of electricity, but that, after the comb had been drawn through, it bushed out in a most surprising manner, by the mutual repulsion of the hairs, and occasioned, on rising upon her head, a most singular and disagreeable sensation, which would certainly have frightened her terribly, if she had not instantly guessed the cause.

It must not, however, be taken for granted, that these appearances are quite common here, or that they appear every winter, although we never fail to have 24° and upwards of cold, by REAUMUR's scale. No; to render these effects very remarkable, a great cold must have continued several weeks without abating, as I shall explain in the sequel.

I SHALL here likewise account for a curious fact mentioned above, which must have drawn the attention of the reader, *viz.* that Prince ORLOFF became electrified whilst sitting at his toilet,

toilet, on a chair placed on the bare floor, or on walking in the Great Duke's apartment, without any species of apparatus to cut off his communication with the naked boards; but he was in fact insulated in both situations, as the inlaid floors were become as completely ideo-electric as glass or rosin, from the high dried state to which they were reduced by an exsiccating quality of the atmosphere, (to be explained in the sequel) and constant waxing. Now, as I observe, Sir, that in your paper on our climate, you enter into some reasoning on these phenomena, I presume my opinion on them will not be disagreeable to you.

THE great disposition, then, of air, and other bodies, to become electric, during great degrees of cold continued for a certain time, always appeared to me to be so easily explained,* that I looked upon it as a simple corollary of the best known of the laws of electric force, and as such, that it did not require to be deduced from it in a formal manner. However, that you may know on what I founded that supposition, I shall observe, That, *first*, nothing indicates air, and other bodies, to contain, during severe frost, an atom of more electric matter than their natural quantity; and they are certainly not in a state of spontaneous electricity, because, to render them electric, friction must be employed, as at all other times; so that all the uncommon appearances above mentioned are reduced to this, That, by means of friction, bodies, in the above state of the atmosphere, become more easily, and more strongly, electric, than at any other time, which does not indicate a larger quantity of electric matter, but a greater disposition to receive it.

2dly, THERE is no necessity, then, to enquire, why air, silk, wool, hair, wood, &c. contain a greater quantity of electric matter in this than in another season, since the fact does not obtain; so that the question left for investigation is only, Why they possess, during severe cold, a greater aptitude or disposition

to

to become electric, than in any other state of the atmosphere? or, in other words, Why they become, in a more eminent degree, *ideo-electric*?

3dly, AIR possesses, like the other fluids we call *menstrua*, the power of dissolving different bodies, especially water, which last process we term evaporation; and, like the other *menstrua*, this power is modified by the degree of heat it possesses, so that, *cæteris paribus*, warm air can dissolve, and hold in solution, a much greater quantity of water than cold air.

4thly, SUPPOSE that air, heated to a given degree, holds in solution as much water as it is able to dissolve, that is to say, that it is saturated with it, and it then cools down so considerably, that it cannot hold in solution the same quantity it did at first; there should, in that case, take place a large precipitation, or a large portion of the dissolved water should separate itself from the cooled air; so that it must remain charged with a much smaller quantity than before it lost its heat.

5thly, IT follows, then, that the atmosphere is never drier than during great frost, and never more humid than during great heat; and this assertion will appear a paradox only to those who confound a dry with a drying air, and a wet with a wetting air; or who do not reflect that a dry air may not be of a drying nature, and that a humid atmosphere may not be of a wetting quality. I hope, likewise, nobody will maintain, that the apparent purity, and perfect transparency of the air, in a fine summer day, is a proof of its not being charged with heterogeneous matter, as that transparency is only the effect of a perfect solution of the water it contains.—It is evident, by the common chemical operations, performed every day, that every perfect solution is clear and transparent, and that when it becomes turbid, a precipitation is at hand. Let us confirm this fact, Sir, by a phenomenon we have an opportunity of seeing very often in summer, *viz.* that we shall find the air full of
broken

broken clouds in the morning, which vanish under our eye whilst looking at them, as the sun rises higher above the horizon, in the same manner as chemical solutions become turbid on cooling, and clear again on heating.

6thly, THIS extraordinary dry air penetrates into our apartments, either gently and insensibly through chinks, or rapidly and perceptibly when our stoves are lighted each morning; a sure means of renewing the air of our apartments once in twenty-four hours at least. The external air thus introduced, soon acquires the temperature of the chamber, which is commonly from 12° to 15° or more of REAUMUR, (in the better sort of houses, for those of the common people are warmer) and then recovers its dissolving power, which the severity of the cold had considerably diminished, nay almost entirely overcome; but as it now contains little or no humidity, it must, like other *menstrua*, attack the humidity that it finds in the chamber, with a much greater rapidity than it could have done with the same degree of heat, had it not been thus purified (or dephlegmated, in the language of chemistry) by the cold. All the bodies, then, which happen to be in the room, must lose of their humidity, or be dried much quicker than in any other season; and, in fact, there is no housekeeper in Petersburg who does not perceive to his cost this extraordinary drying process, as our furniture warps, cracks or splits much more during the rigour of winter, than in the hottest period of summer, nay probably more than in any other country between us and the equator.

7thly, A NATURAL result of all this, is, that, after our great cold has continued a certain time, the bodies mentioned above, *viz.* air, silk, wool, hair, wood, &c. are in fact, without assistance from us, drier than during the rest of the year, and probably more so than in any other part of Europe, except they are dried expressly by some artificial means.

8thly,

Stbly, Now, the bodies I have enumerated, are all in the class of imperfect ideo-electrics, and have likewise the common property of attracting moisture, so that they can never be perfectly dry; but water is, after the metals, the most perfect conductor of the electric fluid, or the least of an ideo-electric, I say, after the metals; for I think I have observed, and probably others have done the same, that water does not conduct quite so well as they do. But let that be as it may, these bodies cannot certainly imbibe water without becoming less of an ideo-electric, in proportion as they do so, and, of course, the more they dry again, the more they recover their natural quality.

THE result upon the whole then must be, That during our severe cold, the bodies of which I speak become spontaneously much better ideo-electrics here, than they ever are in any other season or climate; therefore these bodies have an extraordinary disposition to become easily and strongly electric.

It cannot have escaped your penetration, Sir, that in all I have said, I have advanced only known and generally received facts, without admixture of hypotheses or conjecture of my own; so that the explanation I have given of the phenomena, (alluded to in your paper, and which I was called upon to illustrate) arises naturally and necessarily from those facts, in such a manner, that it may pass, in my opinion, for a demonstration, such as is to be given in Natural Philosophy.

It appears to me then, Sir, that we are not obliged to have recourse to the conjectures of Messrs SAUSSURE, BERGMAN, WILKE, &c. to explain the above phenomena, as you appear to have been disposed to do, in the passage alluded to, with a moderation that does honour to your mode of philosophising; nay, if we were even inclined to employ them, I do not see how they would answer our purpose, being only hazarded opinions; but could they be verified, (which I doubt much) they would even then be of very little use, as they could contribute nothing to the perfection of the theory of electricity.

You

YOU must excuse me, Sir, if I enter into another discussion which the same passage of yours has likewise given rise to. I mean, the opinions which several of the learned have thrown out of late years relative to two sorts of electricity.

IT was I, Sir, as you know, who first gave rise to that idea many years ago. I had proved, in my *Tentamen Theor. Electric. et Magn.* that the portions of matter belonging to every body in nature, repel one another. This proposition appeared bold to some of the learned, as indeed it would have done to myself, before I had well examined, digested and compared it with the analogy of nature.

THE Philosophers you cite imagine they could remove this difficulty, by supposing the existence of two distinct electric fluids, one of which is positive and the other negative. I shall confine myself at present to a few remarks upon that subject.

Imo, THOSE who would pass that idea for a new theory of electricity different from mine, (and there are those who attempt it) have not considered matters in their true point of view; for it is evident that a theory, founded on the supposition of two fluids, will coincide perfectly and essentially with mine; nay, the explanation of the phenomena, the reasoning, and even the analytic formula which they draw from their pretended theory, is exactly the same as mine. But supposing their hypotheses could be proved, there would result from it nothing new, except that it might furnish an explanation of one of the fundamental facts on which I founded my theory, and which I did not follow, nor think important enough to investigate the origin of, but was contented to admit it as an established fact.

2do, My theory, in confining itself to simple well attested facts, neither assists nor denies the existence of two, or even several fluids, which nature might possibly employ to effect the fundamental laws on which I have established my theory; for when I make use of the expression *matter proper to bodies*, it is evident, that it means what remains in a body after we have drawn off the electric fluid.

3^{tho}, In consulting the analogy of nature, one cannot fail to recollect, that all known bodies possess, besides the Newtonian attraction, which is common and general to them all, another attractive force, or that which produces cohesion between two pieces of polished marble, the ascent of fluids in capillary tubes, and an infinite number of other phenomena. Now, this last attractive force is evidently and essentially different from the first; for whilst the one follows the inverse ratio of the square of the distance, it is proved that the other is in proportion to a power, into which enters the reverse ratio of the cubes, and probably of some still higher power of the distance.

If then both experience and the analogy of nature, show the possibility of the co-existence of two attractive forces in the same body, governed by laws entirely different; and as a repulsive force is nothing else than a negative attractive one, my supposition of the repulsive force of bodies, contains nothing but what is perfectly conformable to the analogy of nature.

You also make mention, Sir, and with reason, of the frequent appearance of the beautiful phenomena of parheliisms and mock moons in our climate, which enables us to be better acquainted with all the circumstances attending them, than people nearer the equator. I paid a particular attention to these phenomena for a part of the years 1758 and 1759, and I think I have made some important observations on that subject; but it is not at present either the time or place to enter into them, especially as I have already given the principal facts in a paper inserted in the eighth volume of the *Novi Comment. Academ. Scien. Petrop.* p. 392, by referring to which I shall content myself at present.

It is now time, Sir, to finish this long letter, which has almost swelled to a dissertation; and I shall do so, by assuring you, that I am, with much esteem,

Your obedient servant,

St PETERSBURG, }
Jan. 7—18. 1789. }

ÆPINUS.

SIR,

S I R, *January 23. 1789.*

AN idea has struck me since I sent off my last letter, which may possibly merit your attention, and therefore I shall give it you.

BOTH of us know long ago, Sir, and we have probably felt it lately, that when a severe frost has lasted for a certain time without intermission, we may in vain strive to prevent feeling its effects on our own bodies, as well as our furniture, although we even remain within doors in a comfortable spring heat, without exposing ourselves to the open air at all. It might be supposed that these precautions would be sufficient; but they are in fact far from being so: for as soon as the severe cold has lasted some time, we find ourselves attacked with a disagreeable sensation, which, like all the rest of our sensations, there is no describing exactly. I shall therefore only say, that it consists in a sort of lassitude and heaviness or torpor, affecting both the body and mind, joined to a troublesome restlessness or inquietude. Such are our feelings during the continuance of the above described weather, and I shall next give you, Sir, my conjectures on the cause of this curious phenomenon.

IN the letter I had the honour to write you some weeks ago, I proved, that great cold renders the air dry and pure in a most astonishing degree, and that the heat which it afterwards receives in our apartments, renders it drying in a proportion equally surprising. Now, is it not possible that it is this same drying quality of our chamber-atmosphere which produces the sensations enumerated above? For why should it not attack, under the same circumstances, the human body, as well as our wooden furniture, and all other bodies which happen to be in the rooms? Surely, what we call perspiration must be much increased by it; and this consumption of our excreted fluids may possibly be extended, I should think, to the nobler fluids
necessary

necessary to the functions of the animal œconomy, such as what are called vital spirits, the existence of which is supposed, with some degree of probability, without our being able to say what they are. This idea appears the more likely, as it is known that the dissolving power of air is not confined to water alone, but is extended to many other bodies. If then my conjecture is founded, there appears to me, Sir, a very easy way to prevent this sort of disease; for in fact it is one, although but slight and of little consequence; we have only to give back to the air the humidity which the frost had robbed it of, which may be done, either by promoting the evaporation of a certain quantity of water in the room, or, what will be a much more convenient and shorter mode of doing it, to hang up a cloth of a proper size, dipped in water, and wetted from time to time.—I submit, Sir, these conjectures to your judgment; as all that regards the impression which, in length of time, may be made on the human body, by a very dry and a very drying air, falls more immediately into your line as a Physician, than into that of your most obedient servant,

ÆPINUS.

You may make what use you please of this letter, and give it the same destination as the first, if you think proper.

END OF PAPERS OF THE PHYSICAL CLASS.

The MEAN STATE of the Weather, kept by Profeffor EULER

For the fix Winter Months, November, De
and April, which make 181 days of the

At 20 feet above the mean level of the N
into the Gulph of Finland.

At higheft,	28.87	comm
At loweft,	26.99	often

Difference,	1.88	The n
Mean height,	28.02	Paris inch
It ftands 95 days above 28 inches,		

DE L'ISLE's Thermomet

Greatest cold,	196°	commonly in January,
		HEIT, or $24^{\circ}\frac{1}{2}$ of R
Least cold,	141°	in November or April,
		$5^{\circ}\frac{1}{2}$ of REAUM. abo

Difference,	55°	equal to 64° of FAHR.
Mean cold of the night, 162° equal 23° of FAHR		
below 0. And of the afternoon, 154° equal 27		
of REAUM. below 0.		

The cold has been above 170° for 47 nights, equal
to $10^{\circ}\frac{2}{3}$ of REAUM. below 0. And above 150°
nights.

The mean term of the first froft, the 9th Otober,
The mean term of the Neva freezing, the 27th N

Perfect calm,	28 days.		
Brisk gales,	50 days.		
N. 14 days.	E. 23 days.	S.	
N. E. 19 —	S. E. 12 —	S. 1	

IV.

Sky clear,	39 days.	Cloudy, 68 days
Fog,	26 —	
Rain,	20 —	
Snow,	64 —	Mean term of the fir
Quantity of rain and melted fnow, $4\frac{27}{100}$, or 2		
Aurora Borealis,	16 or 17 days.	
Tempeft,	feldom.	
Hail,	very feldom.	

The MEAN STATE of the ATMOSPHERE in St Petersburg, for Sixteen Years, extracted from a Register of the Weather, kept by Professor EULER, perpetual Secretary to the Imperial Academy of Sciences.

For the fix Winter Months, November, December, January, February, March and April, which make 181 days of the common year.

For the fix Summer Months, May, June, July, August, September and October, which make 184 days of the year.

I. B A R O M E T E R.

At 20 feet above the mean level of the Neva, and at 6000 feet from its falling into the Gulph of Finland.

At highest,	28.87	commonly in January.
At lowest,	26.99	oftenest in November.
Difference,	1.88	The mean between these extremes, 27.93.
Mean height,	28.02	Paris inches.
It stands 95 days above 28 inches, and 86 days below it.		

N. B. The scale of the barometer is divided into Paris inches and hundredth parts.

At highest,	28.47	oftenest in May or October.
At lowest,	27.50	oftenest in September or October.
Difference,	.92	The mean between these extremes is 27.96.
Mean height,	28.04	Paris inches.
Its height for 107 days is above 28 inches, and for 77 days below it.		

II. T H E R M O M E T E R.

DE L'ISLE's Thermometer in the shade, and exposed to the north, the instrument in use in the Imperial Academy of Sciences.

Greatest cold, 196° commonly in January, equal to 24° below 0 of FAHRENHEIT, or 24° $\frac{1}{2}$ of REAUMUR below 0.

Least cold, 141° in November or April, equal to 57° of FAHR. above 0, or 5° $\frac{1}{2}$ of REAUM. above 0.

Difference, 55° equal to 64° of FAHR. or 28° $\frac{3}{4}$ of REAUM.

Mean cold of the night, 162° equal 23° of FAHR. above 0, or equal 7° of REAUM. below 0. And of the afternoon, 154° equal 27° of FAHR. above 0, or equal 2° of REAUM. below 0.

The cold has been above 170° for 47 nights, equal to 8° of FAHR. above 0, or equal to 10° $\frac{3}{4}$ of REAUM. below 0. And above 150°, or the freezing point, for 156 nights.

The mean term of the first frost, the 9th October, new stile.

The mean term of the Neva freezing, the 27th November.

Greatest heat, 106° commonly in July or August, equal to 85° of FAHR. above 0, or to 24° $\frac{1}{2}$ of REAUM. above 0.

Least heat, 144° in May or October, equal to 41° of FAHR. above 0, or to 3° of REAUM. above 0.

Difference, 38° equal to 46° $\frac{1}{2}$ of FAHR. or equal to 20° $\frac{1}{2}$ of REAUM.

Mean heat of the afternoon, 127°, equal to 59° of FAHR. above 0, or equal to 12° of REAUM. above 0. And of the night, 136°, equal to 49° of FAHR. above 0, or to 2° $\frac{1}{2}$ of REAUM. above 0.

The heat of the afternoon has been 130°, equal to 56° of FAHR. above 0, or 10° $\frac{3}{4}$ of REAUM. above 0; and above 150° for 182 days: That is to say, that the thermometer has been so many days above the freezing point.

The mean term of the last frost, 3d of May, new stile.

The mean term of the opening of the Neva, 19th of April.

III. W I N D.

Perfect calm,	28 days.	Light breezes,	87 days.
Brisk gales,	50 days.	Strong gales,	16 days.
N. 14 days.	E. 23 days.	S. 20 days.	W. 45 days.
N. E. 19 —	S. E. 12 —	S. W. 22 —	N. W. 26 —

Perfect calm,	41 days.	Light breezes,	75 days.
Brisk gales,	53 days.	Strong gales,	15 days.
N. 32 days.	E. 19 days.	S. 22 days.	W. 27 days.
N. E. 15 —	S. E. 18 —	S. W. 24 —	N. W. 27 —

IV. S K Y A N D A T M O S P H E R E.

Sky clear, 39 days. Cloudy, 68 days. Overcast, 74 days.

Fog, 26 —

Rain, 20 —

Snow, 64 — Mean term of the first snow, Oct. 9. N. S.

Quantity of rain and melted snow, 4 $\frac{27}{100}$, or about 5 inches.

Aurora Borealis, 16 or 17 days.

Tempest, feldom.

Hail, very feldom.

Sky clear, 53 days. Cloudy, 87 days. Overcast, 44 days.

Fog, 17 —

Rain, 80 —

Snow, from 6 to 7 days. Mean term of the last snow, 4th of May, N. S.

Quantity of rain-water, 10 $\frac{26}{100}$, or about 11 inches.

Aurora Borealis, from 8 to 9 days.

Tempests, from 11 to 12 —

Hail, from 2 to 3 —

II.

PAPERS OF THE LITERARY CLASS.

- I. *An Account of some EXTRAORDINARY STRUCTURES on the Tops of Hills in the HIGHLANDS; with Remarks on the Progress of the Arts among the ancient Inhabitants of SCOTLAND.* By ALEXANDER FRASER TYTLER, Esq; Advocate, F.R.S. EDIN. and Professor of Civil History in the University of EDINBURGH*.

IN the year 1777, an account was published by Mr JOHN WILLIAMS, mineral-engineer, of certain remains of ancient buildings on the summits of some of the hills in the Highlands of Scotland, which had hitherto escaped observation, and which to him afforded grounds for a very extraordinary supposition, That they had been cemented together by means of Fire. He mentioned several of those hills exhibiting remains of building, which he had visited and examined; particularly the hill of Knockfarril in Ross-shire, Craig-Phadrick near Inverness, Dun-Evan and Castle-Finlay in the county of Nairn, and the Castle-hill of Finhaven in the county of Angus. He described the vestiges of regular fortifications on the summits of

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those

* Part of this Paper was read in 1783, before the Philosophical Society of Edinburgh. It is now enlarged, and printed by order of the Committee for publication of the Transactions of the Royal Society of Edinburgh.

those hills, of which the walls, remaining in some places of several feet in height, were evidently compacted together by the vitrification of the stones of which they were built; and he offered some ingenious conjectures with regard to the means employed in forming such extraordinary structures, and the purposes for which they might have been reared.

THIS account, which Mr WILLIAMS himself candidly owned, was by many people treated as a fiction, excited, however, the curiosity of several travellers to visit and examine some of those hills which he had mentioned. In the same year, 1777, Dr JAMES ANDERSON of Monkhill, transmitted to the Society of Antiquaries of London, a very elaborate account of some ancient monuments and fortifications in the Highlands of Scotland, contained in two letters, which are published in the 5th and 6th volumes of the *Archæologia*. In these he treats, at considerable length, of the vitrified forts, and particularly of that upon the hill of Knockfarril in Ross-shire; and, agreeing with Mr WILLIAMS in the general idea, that, in rearing those structures, the builders had employed fire for the purpose of cementing the materials, he differs from him a little as to the manner in which he supposes the fire to have been applied to the mound or rampart.

IT is curious to remark, how the same appearances, to different observers, lead to the most opposite opinions and conclusions. The two gentlemen above mentioned seem not to have entertained the smallest doubt, that the vitrified materials on the tops of those hills, were the vestiges of works of art, and the remains of structures reared for the purposes of security and defence. The Bishop of Derry, when on a tour to the north of Scotland, visited the hill of Craig-Phadrick near Inverness, and expressed his opinion, that the mounds of vitrified matter were not the remains of any artificial work, but the traces of an ancient volcano. In the Philosophical Transactions of the Royal Society of London for 1777, Part II. No. 20. is an account

count of *Creck Faterick*, there termed a *volcanic hill near Inverness*, in a letter from THOMAS WEST, Esq; to Mr LANE, F. R. S. in which the writer does not hesitate to pronounce this hill an extinguished volcano; and having sent specimens of the burnt matter for the inspection of the Royal Society, the Secretary subjoins a note to the paper, intimating, that “ these specimens “ having been examined by some of the Members well acquainted with volcanic productions, were by them judged to “ be real lava.” Such was likewise the opinion of a very ingenious Member of this Society, the late ANDREW CROSBIE, Esq; who, in an account which he gave to the Philosophical Society of Edinburgh in 1780, offered some curious conjectures with regard to the process of nature, by which he supposed the whole of this hill to have been thrown up from the bottom of the sea by the operation of intestine fire.

THE perusal of Mr WILLIAMS’s pamphlet and of Dr ANDERSON’s account, as well as those differing opinions I have mentioned, excited my curiosity, in a journey I made to Invernessshire in autumn 1782, to examine, with some attention, such of the hills mentioned by Mr WILLIAMS as lie in that country; and I now propose to lay before this Society the result of that examination, which, however, I confine chiefly to Craig-Phadrack, as that which I have most minutely surveyed.

CRAIG-PHADRICK is a small conical hill, which forms the eastern extremity of that ridge of mountains which bounds Loch-Nefs upon the north-west side. It is situate about a mile to the north of Inverness, and commands an extensive prospect of both sides of the Murray frith, to the distance of above forty miles. It is accessible on two different quarters; on the west by a narrow but level ridge, which joins it to the chain of hills upon Loch-Nefs; and on the south-east, by an easy ascent from the high ground above the town of Inverness. When seen from the opposite heights, it appears pretty much of a conical figure; the top cut off, forming a level surface, bounded at
each

each end by a small rising or shoulder. At the distance of three or four miles, its artificial appearance is more perceptible than upon a nearer approach, when the eye, seeing only a part, fails to take in the great outlines, and to perceive their regularity and symmetry. A more distinct idea of the general form of this hill than can be given by description, may be obtained from a sketch taken from the opposite high grounds, at a few miles distance. See Plate I. fig. 1. In this sketch, Craig-Phadrick is marked by the letter C. B are those hills, a part of the same ridge, which bound Loch-Nefs upon the north-west; and D is a conical hill opposite to Craig-Phadrick, on the other side of the Murray frith.

ON approaching Craig-Phadrick from the level ridge upon the west side, what first presents itself to view is a road cut through the rock, from the bottom to the summit; in most places about ten feet in breadth, and nearly of the same depth, winding in an easy serpentine direction for about seventy feet; by which means an ascent is gained over a very steep rock, which is otherwise quite inaccessible from that quarter. See Plate I. fig. 2. The form alone of this road leaves little room to doubt of its being an operation of art. I examined the sides of it, where it is cut into the rock, to see if there were any marks of a tool. A labourer, who attended me with a mattock, or quarryman's pick, declared his opinion, that, in many places, there were marks of an instrument similar to what he had in his hand; but the rock being composed of many rounded pebbles, and when broken presenting a surface, in which the beds of those pebbles have often an appearance like what is made by the stroke of a tool, I lay little weight upon that circumstance. The form alone of this road, as I have already said, was sufficiently convincing to me of its being an operation of art.

FROM the nature of the stone itself, of which this hill is formed, and from that compound appearance of water-worn pebbles, sticking in a cementing mass, it has been conjectured, that

that these pebbles, together with the bed in which they are lodged, had been forced up from the bottom of the sea, by internal fire struggling for a vent, which it afterwards obtained at the summit. With regard to the nature of the stone of this hill, I shall here observe only, that this compound appearance in the rock at Craig-Phadrick, affords no more presumption of this particular hill being forced up by fire from the bottom of the sea, than it does of all the surrounding hills for many miles having the same origin. The greatest part of the hills which bound Loch-Nefs, both on the north and south, are composed of the same materials, or at least contain large strata of the stone I have mentioned. Yet none of those hills that I have seen, or on enquiry have ever heard of, exhibit the smallest appearance of the effects of fire; though, being infinitely higher than Craig-Phadrick, and consequently demanding a much greater force to raise them up, had fire been the agent, its effects on them would probably have been much more conspicuous than on a hill incomparably smaller.

THAT the materials which compose the hill of Craig-Phadrick, as well as all other hills, of which the stone is of a similar nature, have originally been under water, I have not the smallest doubt. The compound appearance of the rock, which is evidently a mass of water-worn pebbles, of various size, nature and colour, sticking in a bed of clay, leaves no room to doubt of its origin. But whether those hills, which consist of such compound materials, have been forcibly raised up from the bottom of the water, by some convulsion of nature, or formed by a gradual *alluvio*, or deposition of materials under a mass of water which has now deserted them, (as sand-banks are formed in the sea) is what we have no grounds for determining with certainty, and few to found even a probable conjecture: Since, with regard to this particular hill, there never has been a section made across any part of it, from which the component strata might be perceived, or the disposition in
which

which they lie. All that I am at present concerned to shew, is, that, from the superficial or external appearance of this hill, there is no reason for supposing that it ever contained intestine fire.

THE stone, of which the whole of this hill, and most of the neighbouring hills are composed, is a mixed mass of round water-worn pieces of different coloured granite, greyish or speckled quartz, and the common white quartz. This compound stone, which is well known to miners, has, from its appearance, been termed *plum-pudding* stone. Those who have entertained the notion of Craig-Phadrick's being an extinguished volcano, have maintained, that this compound stone is of the nature of the volcanic *tufas*. This, however, will be acknowledged to be a mistake, by all who have examined and compared the two substances. The volcanic *tufas* are all composed of materials which have undergone a change by fire; the plum-pudding stone has undergone no such change. Sir WILLIAM HAMILTON describes tufa to be a soft stone, composed of pumice, ashes and burnt matter, its colour often tinged with grey, green and yellow. It is formed, says he, by water making up these materials into a sort of clay, which afterwards hardens. The plum-pudding stone, on the contrary, contains no burnt materials. Its component parts, so far from being already burnt, when exposed to fire, undergo a total change, and the whole stone suffers an imperfect vitrification. Upon the whole surface of this hill, and amidst all the detached fragments, both of the natural stone and of the vitrified matter, there is not, so far as I could observe, any thing that bears the appearance of a pumice stone. The burnt matter, indeed, is often full of small holes or honey-combed; but it still retains a glassy appearance and a considerable weight, both which circumstances sufficiently distinguish it from pumice. *Basaltes* are, I believe, constantly found, in some form or another, upon all volcanic hills; but neither on the rock of Craig-Phadrick, nor on any of the neighbouring

bouring hills is there, so far as I could observe, the smallest appearance of that kind.

THE vitrified matter on the summit of this rock is, therefore, the only circumstance which positively vindicates the effect of fire; and this I shall now proceed to examine.

THE Society have already had before them specimens of this burnt or vitrified matter. I shall, therefore, suppose, that they are sufficiently acquainted with its appearance. It will be recollected, that in none of the specimens which were produced, was there any thing like a total fusion of the materials. Some parts of the mass seemed to be portions of argillaceous and unvitriable stone; others of stones of which a part had been in fusion, while the rest remained in its natural state. These circumstances, of themselves, are sufficient to distinguish this substance from volcanic lava, which is an uniform homogeneous mass, of which every part has been in a state of fusion. Neither has this vitrified substance the appearance of those *scoriae* thrown up from volcanos, which are probably the scum of the lava, or such parts of the materials as either never were fusible, or have lost their fusibility and principle of inflammability: For the burnt substance on the top of Craig-Phadrick is rather a mixture of fusible with unfusible substances; many parts appearing to have been in the most perfect fusion, while others have remained in their natural state.

BUT the circumstance which, in my apprehension, evinces, in the most satisfactory manner, that those appearances of the effect of fire on the summit of this hill, are not the operation of nature, but of art, is the regular order and disposition of those materials, the form of the ground, and the various traces of skill and contrivance which are yet plainly discernible, though considerably defaced, either by external violence, or by the obliterating hand of time. To proceed regularly in examining those appearances of artificial contrivance, I return to that winding road I before mentioned, which is evidently cut

through the rock for the purpose of gaining an easy ascent from the level ridge to the summit, which would otherwise have been impracticable.

IN mounting up by this road, and towards the middle of the ascent, there appears a small platform overhanging the road, upon the right hand, and inclining, by a very gentle declivity, to the edge of the rock. Upon this platform, and on the very edge and extremity of it, are placed four enormous stones, which have been evidently guided by art into that position; as it is impossible, supposing them to have rolled down, that they ever could have rested in that situation. The posture of these stones leaves no doubt as to the purpose they were intended to serve. Upon an alarm of danger, the strength of a very few men was sufficient to raise these enormous stones so as to destroy their balance, and project them into the hollow road, which they would entirely block up, and thus either prevent all access, or render the pass so difficult, as to be with ease defended by a few against any number of assailants. This winding road, with the platform upon the right, may be seen in Plate I. fig. 2. which is a sketch of the top or cone of the hill, as it rises from the level of the ridge to the west. Some other large stones are likewise placed on an eminence to the left of the road, evidently to serve a similar purpose with those on the right, and to block up or defend a hollow channel, by which an ascent might have been attempted, by following the waving direction of the natural furrows of the hill at B, C and D.

ON arriving at the summit of the hill by the winding road, and a few feet below the rampart which crowns the top of the hill, there appears an outward wall surrounding the whole, which approaches on the sides of the hill so near to the upper rampart, as to leave only a fossé or trench of ten or twelve feet in width between them; unless at the west extremity, where this outward wall extends itself to a greater distance from the inner rampart, and forms a level platform, of an oblong and
somewhat

somewhat semi-circular shape, about forty yards in length, and fifteen at its greatest breadth. In Plate II. fig. 1. which is a ground-plan of the whole works upon the summit of this hill, the outward wall is marked by the letters P, M, N, X, Q; and at P is the level platform above mentioned. This outward wall is in many places so low, as to be almost level with the rock, though, in other places, it rises to the height of two or three feet; but even where it is lowest, the marks of it may be traced by a line of vitrified matter sticking fast to the rock, all along nearly of the same breadth, which, in most places, is about nine feet. The remains of this wall are strongly vitrified, unless in one place upon the north side, where, for about seventy yards, the rampart is formed only of dry stones and earth. The probable reason of this I shall afterwards mention. It is sufficient just now to observe, that the strong natural defence that was afforded on this side, by the extreme steepness of the rock, which is here almost perpendicular, superseded the necessity of much artificial operation, there being little hazard that an assault would ever be attempted on this quarter.

EVERY where else this outward wall appears completely vitrified; and at the east side, where the hill is more accessible, and the declivity more gradual, there is a prodigious mound of vitrified matter, extending itself to the thickness of above forty feet. At the south-east corner, and adjoining to this immense mound, is an out-work, consisting of two semi-circular vitrified walls, with a narrow pass cut through them in the middle. This appears to have been another, and perhaps the principal entry to the fort. It was necessary that there should be two entries; one from the level ridge which joins this hill on the west to that chain of which it forms the extremity, the other from the low country to the east. The entry to the west was defended in the manner already described; that towards the east did not admit of a defence of the same kind, but was secured by three ramparts; and the pass through the semi-circular

lar out-work was made so narrow as to be easily defended, or even blocked up with stones and earth, upon the shortest notice of danger.

WE come now to the inner wall surrounding the summit of this hill, and inclosing a level space, of the form of an oblong square, about seventy-five yards in length and thirty in breadth, rounded, like the outward wall, at each of the ends. This inner wall is nearly of the same thickness with the outward one, and is of considerable height. There is some appearance that it has been armed with four bastions or turrets; as, at regular distances, at those places marked d, d, d, d, (Plate II. fig. 1.) the wall enlarges itself considerably in thickness, in a circular figure, like the foundation of a small tower. Of this, however, the traces are so imperfect, that I will not take upon me to say whether they may not be entirely an accidental irregularity. In the same light I was at first disposed to have considered the circle C, consisting of a number of small *tumuli* of earth, with a stone placed in the centre, which I supposed might have been nothing more than an accidental appearance, till lately, that, from the description of some ancient fortifications of a similar kind in Ireland, I find there are, in many of them, circles of small *tumuli*, like what I have mentioned, which are supposed to have marked the place set apart for the chief, as the *prætorium* in the camps of the Romans.

BUT within this inner space, there are other marks of artificial operation, which are less ambiguous. On looking at the ground-plan, (Plate II. fig. 1.) there appears, on the east side, a portion of the internal space, marked S, which is separated from the rest by two ranges of stones strongly fixed in the ground, in the form of a rectangular parallelogram. This separation is immediately discernible by the eye, from this circumstance, that the whole of the inclosed summit has been most carefully cleared from stones, of which there is not one to be seen, unless those that form this division, and the single stone

stone in the middle of the circle of *tumuli* above mentioned. What has been the design of this separated space, is difficult to conjecture. It might, perhaps, have marked the residence of those of a higher rank, or served as a temple for the purposes of devotion.

TOWARDS the east end of the large area on the summit, and at the place marked q in the plan, are the vestiges of a well, about six feet in diameter, which has probably been dug deep into the rock, though it is now filled up with rubbish to within a yard of the surface.

SUCH are the appearances on the summit of Craig-Phadrick, which exhibit, in my opinion, such evident and unambiguous traces of artificial operation, that I cannot conceive a difference of opinion to have arisen concerning their origin, but from too inattentive and hasty a survey of them, joined to a partiality for those hypotheses, extremely fashionable at present, which ascribe a vast variety of natural appearances to the operation of ancient volcanos.

OF those fortified hills mentioned by Mr WILLIAMS, I had likewise an opportunity of examining two others, the hill of Dun-Evan in the County of Nairn, and the Castle-hill of Finhaven in the county of Angus.

ON the summit of the hill of Dun-Evan, (of which the name implies that it had been originally a place of defence) there have been two walls or ramparts surrounding a level space of the same oblong form with that upon Craig-Phadrick, though not quite so large. There are likewise the traces of a well within the inclosed area; and at the east end, as at Craig-Phadrick, there are the remains of a prodigious mound or mass of building, much more extensive than that which we have remarked upon the former hill. In all these operations, which, in their form, are perfectly similar to those on Craig-Phadrick, there are not, however, so far as I could perceive, any marks of vitrification or the effects of fire. Mr WILLIAMS, in his description of Dun-Evan, says, that the vitrified ruins are more
wasted

wasted here than upon Knock-farril or Craig-Phadrack ; but as neither I myself, nor two other gentlemen who examined this hill along with me, could perceive the smallest appearance of vitrification, I am inclined to believe, that, in this instance, Mr WILLIAMS's fondness for his new discovery has a little blinded him in his observations. Dun-Evan has, in my apprehension, been fortified with walls of dry stone and earth ; but these of great thickness, and very compactly built, as appears by their remains at this day. The entry Mr WILLIAMS supposes to have been at the east end, where there has been, as already observed, a prodigious rampart of stones. But in this particular he is evidently mistaken. The entry has, without doubt, been upon the west side, where there is a serpentine road from the bottom to the summit, extremely conspicuous, which is visibly continued for a considerable distance along the low ground at the foot of the hill, and is regularly formed, by filling up hollows and levelling rocky heights which lay in its way.

THE inclosed space on the summit of the Castle-hill of Finhaven, is of much greater extent than that upon Craig-Phadrack or Dun-Evan. The area is about 140 yards in length, and above forty in breadth. The vitrified remains of a rampart are extremely visible all around the summit, which is cleared of stones and levelled, unless at one end, where there is a great hollow space separated from the rest of the area, and probably destined exclusively for the keeping of cattle. The remains of structure upon this hill are, in other respects, nearly similar to those on Craig-Phadrack and Dun-Evan.

ANOTHER fortified hill, which is not among those enumerated by Mr WILLIAMS, I have likewise visited, and have examined with particular attention. This is Dun-Jardel, a very high hill, which rises in a beautiful, irregular, conic figure, on the south side of Loch-Nefs, about two miles to the eastward of the fall of Fyers. The summit is accessible only on the
south

south side by a narrow ridge, communicating with the hills of Stratherrick, of which it terminates a small collateral chain. On every other quarter, the ascent is almost perpendicular; and the base of the hill is defended by a very rapid river, which winds along two thirds of its circumference. The inclosed area on the top of Dun-Jardel is an oblong square of twenty-five yards in length and fifteen in breadth. It is, therefore, considerably smaller than any of the three fortified hills above mentioned; but is, from its situation and form, incomparably stronger, and must, in those periods when it was resorted to for defence, have been quite impregnable. The area on the summit is levelled, cleared of stones, and has in it the remains of a well. It is surrounded with a very strong wall of dry stones, which has formerly been of great height and thickness, as may be conjectured from the prodigious quantity of stones that has fallen only from one side of the fortification, and has rested upon the level ridge on the south side. Those parts of the building on the other sides which have gone to decay, must have rolled down the precipice into the river at the bottom. It is remarkable, that, on ascending the conical summit of Dun-Jardel, there is, upon a small shoulder of the hill, about fifty or sixty feet below the fortification on the top, a circle of large stones, firmly fixed in the ground, with a transverse double range of stones, extending from one side, to serve as an avenue or entry to the circle. This is, without doubt, a monument of the same nature with those which are termed Druidical Temples, and must have been appropriated to the same purposes; but whether it had any connection with the fortification on the summit of the hill, I shall not take upon me to determine. It may, however, afford some ground, as I shall afterwards shew, for a conjecture as to the period when those extraordinary fortifications were reared.

IMMEDIATELY opposite to Dun-Jardel, on the north side of Loch-Nefs, is another conical hill called Dun-Sgrebin, on the
summit

summit of which, as I was informed by a gentleman who resides in that neighbourhood, there are similar remains of a fortification, composed of dry stone, like those on Dun-Evan and Dun-Jardel. Mr WILLIAMS mentions a small fortified hill near Fort-Augustus, called Tor-Dun, which is plainly discernible from Dun-Jardel. Dun-Jardel is distinctly seen from Dun-Sgrebin; and from the situation of the country, this last is, in all probability, seen from Craig-Phadrack. Craig-Phadrack is plainly discernible from Knockfarril, and Dun-Evan and Castle-Finlay (a fortified hill in the same neighbourhood) from Craig-Phadrack. Thus, there is a chain of seven fortified hills, commanding a very large tract of country, over which an alarm could be communicated with the utmost celerity; and I think it is not improbable, that, upon a minute survey of the mountainous country, it would appear, that there have been, in some former period, chains of communication of this kind through many of the regions in the northern parts of the island.

NOR were fortified places of this kind peculiar to the northern parts of Britain. The Honourable DAINES BARRINGTON, in a memoir printed in volume VI. of the *Archæologia*, affirms, that there are many such structures of dry stone upon the tops of hills in Wales, and particularly in Merioneth-shire. In Dr BORLASE's History of Cornwall, we are informed, that there are the remains of similar structures in that country. Some of these the author has described under the name of Hill-castles.

IN Ireland, the remains of such fortifications on the tops of hills, are yet much more frequent than in this country.

HARRIS, in his republication of Sir JAMES WARE's *Antiquities of Ireland*, in treating of what are called *Danes raths* or *Danes forts*, in that country, describes precisely such fortifications or structures, as those on the summits of the hills we have mentioned, *viz.* conical mounts terminating in an oblong level area, and surrounded with the remains of strong ramparts.

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The very general tradition, of attributing these fortifications, both in Ireland and in this country, to the Danes, I shall afterwards shew to be quite erroneous. In a collection of miscellaneous essays towards a natural history of Ireland, published by Dr MOLYNEUX, Dr GERARD BOATE, and others, there is an accurate description given of those structures. "Most of those in Ireland," says Dr MOLYNEUX, "are surrounded only by earthen ramparts. Some, though but a few, are encompassed round with walls of stone cast up instead of earth, yet without any mortar. Two of these may be seen at Farmoyle in the county of Longford." The authors of the ancient and modern state of the county of Down, describe particularly five of those fortified mounts, which are but a few, out of a vast many in that single county. On the Rath at Crown-bridge near Newry, there is, at the west end of the level area, and about fifty feet below it, a square platform, such as we have described at the west end of the fortification on Craig-Phadrick. The tradition is, that this platform at Crown-bridge, was the *arena* where two competitors decided, in single combat, the disputed right to the Crown of Ireland. WRIGHT, in his *Lowthiana*, or introduction to the antiquities of Ireland, describes and gives plans of many such fortified mounts, all of which are surrounded by ramparts; and most of them have at the extremities strong outworks below the level of the fort itself. One of these, which is called *Green Mount*, near Castle-Bellingham, appears from the engraving in Mr WRIGHT's book, to bear a near resemblance in its plan to Craig-Phadrick.

NONE of those remains of building upon the hills in Ireland, so far as is taken notice of in the descriptions of them I have mentioned, exhibit any marks of vitrification. Three of the fortifications I have enumerated in the neighbourhood of Inverness, are likewise crowned with dry stone structures, without any appearance of the effects of fire; and I am inclined to believe, that, upon an accurate survey of those extraordinary

works, the number of those that show marks of vitrification will be inconsiderable, when compared with those that have not been at all affected by fire. I am led, from this circumstance, to form an opinion different from that of Mr WILLIAMS, and of such as believe those structures to be the proofs of an ancient mode of building, in which fire was employed for the purpose of cementing, before our ancestors knew the use of lime. I am disposed to think, that the appearances of vitrification on some of those hills, are the accidental effects of fire upon a structure composed of combustible and fusible materials, and by no means the consequence of an operation intended to produce that effect.

THE buildings reared by the ancient inhabitants of this country, both for habitation and defence, would naturally be composed of such materials as the rude state of the country presented in abundance, and such as required little, either of labour or of skill, to bring into use. In those quarters where stone could be easily quarried in square blocks, or where it split into *laminæ*, no other material than the simple stone was necessary, and very little labour was sufficient to rear the structure. Such has been the case at Dun-Jardel and Dun-Evan. But where the stone is of that nature as not to be easily split into square blocks, or separated into *laminæ*, but is apt to break into irregular and generally small fragments, as the rock of Craig-Phadrick, and all others of the plum-pudding kind, it would be extremely difficult to form a regular structure of such materials alone, which should be endowed with sufficient strength. The mode in which I imagine building was practised in such situations, was by employing wood, as well as stone, in the fabric. The building, I suppose, was begun by raising a double row of pallisades or strong stakes, in the form of the intended structure, in the same way as in that ancient mode of building, described by PALLADIO under the name of *Riempita*,

a cassa, or coffer-work *. These stakes were probably warped across by boughs of trees laid very closely together, so as to form two fences, running parallel to each other at the distance of some feet, and so close as to confine all the materials, of whatever size, that were thrown in between them. Into this intermediate space, I suppose, were thrown boughs and trunks of trees, earth and stones of all sizes, large or small, as they could quarry or collect them. Very little care would be necessary in the disposition of these materials, as the outward fence would keep the mound in form. In this way, it is easy to conceive, that a very strong bulwark might be reared with great dispatch, which, joined to the natural advantage of a very inaccessible situation, and that improved by artful contrivances for encreasing the difficulty of access, would form a structure capable of answering every purpose of security or defence.

THE most formidable engine of attack against a structure of this kind, would be fire; and this, no doubt, would be always attempted, and often successfully employed by a besieging enemy. The double ramparts, at a considerable distance from each other, and the platform, at one end, were certainly the best possible security against an attack of this kind. But if the besiegers prevailed in gaining an approach to the ramparts, and, surrounding the external wall, set fire to it in several places, the conflagration must speedily have become general, and the effect is easy to be conceived. If there happened to be any wind at the time, to increase the intensity of the heat, the stony parts could not fail to come into fusion,

C 2

and

* LA maniera *riempiuta* che si dice anco *a cassa*, facevano gli antichi, con tavole poste in coltello tanto spazio, quanto volevano che fosse grosso il muro,empiendolo di malta, e di pietre di qualunque sorte mescolate insieme, e così andavano facendo di corso in corso. Si veggono muri di questa sorte a Sirmion sopra il lago di Garda. Di questa maniera si possono anco dire le mura di Napoli, cioè le antiche, le quali hanno due muri di sasso quadrato, grossi quattro piedi, e distanti tra se piedi sei — e sono empiute di sassi e di terra. PALLAD. *Architect. lib. I. cap. 9.*

and (as the wood burnt away) sinking by their own weight into a solid mass, there would remain a wreck of vitrified matter, tracking the spot where the ancient rampart had stood; irregular and of unequal height, from the fortuitous and unequal distribution of the stony materials of which it had been composed. The appearance at this day of those vitrified mounds creates the strongest probability of the truth of this conjecture. They do not appear ever to have been much higher than they are at present; as the fragments that have fallen from them, even in those places where the wall is lowest, are very inconsiderable. From the durable nature of the substance, they must have suffered very little change from time, though, from the gradual growth of the soil, they must, in some places, have lost, in appearance, a good deal of their height, and, in others, have been quite obscured. Mr WILLIAMS, in making a cut through the ramparts at Knockfarril, found, in many places, the vitrified matter entirely covered with peat-moss of half a foot in thickness.

I HAVE observed, that, in the fortification on Craig-Phadrick, a large portion of the outward rampart upon the north side bears no marks of vitrification. The reason of this it is easy to explain. In the structure of this part of the wall no wood has been employed; for the extreme steepness of the rock on this quarter rendered any rampart for defence entirely unnecessary. A low fence of stones and turf was sufficient here to prevent the cattle, which were probably lodged between the outer and inner rampart, from falling over the precipice. Such is that fence which at present remains on the north side of the rock of Craig-Phadrick.

It appears, therefore, highly probable, that the effect of fire upon those hill-fortifications, has been entirely accidental, or, to speak more properly, that fire has been employed, not in the construction, but towards the demolition of such buildings; and for the latter purpose it would certainly prove much more
efficacious

efficacious than for the former. It is much to be doubted, whether it would be at all possible, even in the present day, by the utmost combination of labour and of skill, to surround a large space of ground with a double rampart of stones, compacted by fire, of such height and solidity as to serve any purpose of security, or defence against a besieging enemy. Any structure of this kind must have been irregular, low, fragile, easily scaled and quite insecure; a much weaker rampart, in short, than a simple wall of turf or wooden pallisade. The vestiges yet remaining, as I have already observed, give no room to suppose, that the vitrified mound has ever been much more entire than it is at present. The effect of fire upon structures reared in the manner I have supposed them to have been, will account most perfectly for their present appearance.

IT was from necessity that the builders of those fortifications betook themselves to a mode of structure so liable to be destroyed by fire. In those parts where stones could be easily quarried, of such size and form as to rear a rampart by themselves of sufficient strength and solidity, there was no occasion to employ wood or turf in its construction, and it was therefore proof against all assault by fire. Such are the ramparts which appear on the hill of Dun-Jardel, Dun-Evan, and many others, on which there is not the smallest appearance of vitrification. But on Craig-Phadrick, and the other hills above described, where, from the nature of the rock, the stones could be procured, only in irregular and generally small fragments, it was necessary to employ some such mode of construction as I have supposed; and these ramparts, though solid and well calculated for defence against every attack by force or stratagem, were not proof against the assault by fire.

BUT those ancient fortifications present a much more curious and more interesting object of speculation, than those uncertain and indeed fruitless conjectures as to the mode in which they have been reared. It is evident, that, were it possible to ascertain.

ascertain the æra in which those fortifications were constructed, some useful light might be thrown upon the ancient history of this country, and the condition of society in those remote periods. This I shall now attempt; and, in the course of a short disquisition upon that subject, shall have occasion to mark the progress of architecture in Britain, from its first introduction into the southern parts, till it had attained to considerable perfection, and the knowledge of the art of building had extended itself, in some degree, to the remotest quarters of the island.

AT the time when those fortifications were reared, it is evident that the use of mortar was unknown. As it must be supposed that the builders exerted the utmost of their architectural skill (so far as strength was concerned) in fabricating those structures, we cannot doubt, that, as the country abounded in lime-stone, had its use been known as a cement, it must have been employed in such works. This brings them at once up to a period of time prior to the Roman establishments in the northern parts of Britain. The Romans employed mortar in all their buildings, of which many remains are at present existing in those parts of the island where they are known to have formed settlements. They taught the Britons the use of that cement, of which, till then, they were ignorant.

AT the time of CÆSAR's invasion of Britain, the inhabitants of the southern, and probably the most civilized part of the island, lived in huts constructed with turf, or with the branches of trees. Their towns or villages were nothing more than an inclosed part of a wood, surrounded by a ditch and rampart, within the circle of which they reared their huts. "Oppidum vocant Britanni cum sylvas impeditas vallo atque fossa munierunt." *CÆs. de Bell. Gal. lib. 5. cap. 21.* These inclosures or towns were but a temporary residence, and probably resorted to, only when it was necessary to defend themselves

themselves against an enemy*. They were so spacious as to afford security, both to the inhabitants themselves and to their cattle. "Urbium loco ipsis sunt nemora. Arboribus enim dejectis ubi amplum circulum sepierunt, ibi casae ibidem sibi ponunt, et pecori stabula condunt, ad usum quidem non longi temporis." STRABO *Geogr. lib. 4.* †. Of this nature were all the British towns in the southern part of the island at the time of CÆSAR. Such was the town of Cassibelanus, probably a place of the greatest consideration in the island, as being the residence of that chief under whom the whole of the southern Britons agreed to unite their forces to oppose the Romans at their second descent upon the coasts. "Ab his cognoscit non longe ex loco oppidum Cassibelani abesse, silvis paludibusque munitum, quo satis magnus hominum pecorisque numerus convenerit." CÆS. *de Bello Gal. lib. 5. cap. 21.* This oppidum Cassibelani was Verulamium, the present St Albans. (See CAMDEN, and HORSLEY's *Britannia Romana.*) London, or the capital of the Trinobantes, was then a place of inferior note to Verulam. The Romans dignified the latter with the title of a *municipium*, while the former was simply an *oppidum*; and therefore strictly correspondent to CÆSAR's general description; a portion of a thick wood surrounded with a ditch and rampart.

IF

* THE picture given by TACITUS of the manner of life of the Germanic tribes, may probably be applied, with very little difference, to all the contemporary barbarous nations of Europe: "Nullas Germanorum populis urbes habitari satis notum est, ne pati quidem inter se junctas sedes. Colunt discreti ac diversi, ut fons, ut campus, ut nemus placuit. Vicos locant non in nostrum morem, connexis et coherentibus ædificiis: suam quisque domum spatio circumdat, sive adversus casus ignis remedium, sive inscitia ædificandi. Ne cæmentorum quidem apud illos, aut tegulorum usus." TACIT. *de Mor. Germ. cap. 16.*

† Πολιεις δὲ αὐτῶν εἰσιν οἱ δρυμοί. περιφραζάντες γὰρ δένδρεσι καταβιβλημένοις ευρυχωρῇ κυκλον, καὶ αὐτοὶ ἐν ταύτῃ καλυβοποιούνται, καὶ τὰ βόσκηματα κατασθμυνοῖσιν, ὅ πρὸς πολὺν χρόνον. STRABO *Geogr. l. 4.*

IF such was the appearance of London at the time of the second invasion of the island by CÆSAR, which happened fifty-five years before the Christian æra, we have certain evidence, that the southern Britons had undergone a remarkable change in their mode of life, and made a great progress in refinement and civilization in the space of 107 years, which elapsed from that time to the great victory gained over the Romans by their Queen BOADICEA. At this latter period, TACITUS mentions London as a flourishing town, which, though not dignified with the title of a Roman colony, was a place of trade and opulence, and a great resort for merchants. “ Londinum quidem cognomento coloniae non insignis, sed copia negotiatorum et comituum maxime celebre.” *Annal. lib. 14. cap. 33.* The Britons of the south had, therefore, profited very greatly by a short intercourse with the Romans; and this progress will appear more remarkable when it is considered, that, from the time of CÆSAR’s invasion to the reign of CLAUDIUS, during almost a complete century, there was no Roman army in Britain, nor any station or settlement of that people in the island*. The Britons, therefore, had, as yet, enjoyed little more than the sight of a polished and improved people. Amidst the tumult of hostilities, there was no opportunity to imitate the practices or study the accomplishments of the people by whom they were invaded; but they saw enough to convince them of their own signal inferiority in all the arts of cultivated life, and to excite a desire to imitate them in a subsequent season of tranquility. This they obtained by the retreat of the Romans; and profiting to the utmost by those lights they had acquired, they made a more rapid advancement to civilization, than perhaps in any after period of their history. Cities were built, harbours constructed

* HORSELEY’S *Britannia Romana*, p. 19, 20.; and TACITUS mentions both the fact and its cause. “ Mox bella civilia et in rempublicam versa principum arma ac longa oblivio Britanniae etiam in pace.” *Vit. Agric. cap. 13.*

structed for the accommodation of mercantile fleets*, and money coined for the medium of trade. The coinage of CUNOBELINE, the successor of CASSIBELANUS, and Sovereign of the Cassii and Trinobantes, from the mints of Colchester, Verulam and London, is a proof, not only of an extensive commerce, but of very considerable advancement in the arts †.

IN this interval, therefore, between the invasion of CÆSAR and the reign of CLAUDIUS, this period of rapid improvement, it is probable the Britons of the south first learned the art of constructing durable buildings with mortar; though we do not find from any classic author, that, before the reign of NERO, the Romans had erected any buildings in the island which could serve as a model of regular architecture. In the fifth year of the Emperor NERO happened that signal defeat of the Romans by the British Queen BOADICEA, occasioned principally by the revolt, or, as TACITUS terms it, the rebellion of the Trinobantes. One great cause of this revolt had been the erection of a magnificent *Temple* to the divine CLAUDIUS, which the Britons regarded as an insulting monument of the Roman power and their own abject slavery. “Ad hæc templum divo CLAUDIO constitutum, quasi arx æternæ dominationis aspiciebatur; delectique sacerdotes, specie religionis, omnes fortunas effundebant.” TACIT. *Annal. lib. 14. cap. 31*. That this temple was a structure of great magnitude and solidity, appears from this circumstance, that the Romans retreated to it as their last strong hold, and, for two days, defended themselves in it against the besieging Britons. “Cætera quidem impetu direpta aut incensa sunt: Templum in quo mi-

VOL. II. D “les

* SEE an accurate account of the commencement of the commerce of Britain in WHITAKER'S History of Manchester, book I. chap. II.

† ABOUT fifty coins of CUNOBELINE have come down to the present times. They are of gold, of silver and of brass; and some of them are elegant in their fabric and device.

“les se conglobaverat, biduo obsessum expugnatumque.” *Ibid.* cap. 32.

THE Britons, prosecuting their success, attacked, pillaged and set fire to several of the Roman forts and garrisons. London and Verulam were destroyed; and, in these two places, (a convincing proof of their magnitude and population) the Britons massacred about 70,000 Roman citizens and their allies *. But these temporary successes were soon checked by a dreadful defeat of the Britons by SÜETONIUS PAULINUS, in which 80,000 were left dead upon the field of battle. From that time, the Romans advanced into the internal parts of the island; and, finding themselves more feebly resisted, as their power became more known, began now to apply themselves to the civilization of the rude people whom they had subdued. JULIUS AGRICOLA, in the second year of his command, as Proprætor of Britain, A. D. 79. reduced the inhabitants of North Wales, of Cheshire and of Lancashire, to absolute subjection, and conquered the isle of Anglesey. Having sufficiently evinced his power, he tried the effect of alluring the natives to an easy submission, by giving them a taste of the enjoyments of a polished people †. Towards this purpose, the Romans encouraged the Britons to build regular towns, assisted them in constructing temples, market-places and commodious dwellings, and taught them even the use of the baths and porticos, and all the luxuries of the Roman banquets ‡. To this
precise

* AD septuaginta millia civium et sociorum iis quæ memoravi locis, cecidisse constitit. TACIT. *Annal. lib. 14. cap. 33.*

† UBI satis terruerat parcendo rursus irritamenta pacis ostentare. JUL. AGRIC. *Vit. cap. 20.*

‡ SEQUENS hiems saluberrimis consiliis absumpta. Namque ut homines dispersi ac rudes, eoque bello faciles, quieti et otio per voluptates assuescerent, hortari privatim, adjuvare publice, ut templa, fora, domos extruerent, laudando promptos, aut castigando segnes—paullatimque discessum ad delinimenta vitiorum, porticus et balnea et conviviolum elegantiam. JUL. AGRIC. *Vit. cap. 21.*

precise period, we may refer the foundation of many of the towns in the west of England, which are known to have had a Roman origin, as Lancaster, Manchester, Warrington, Ribchester, Overborough, Colne, &c. *.

AT this time, therefore, A. D. 79, the Britons of the north-western parts of England, had acquired a considerable knowledge of regular architecture. But all to the north of the Roman conquests, we must presume was in its original state of barbarism. Improvement, however, must have kept pace with the advances of the Romans into the country; and it is therefore not difficult to mark its progress. In the year 80, we find AGRICOLA employed in erecting a chain of forts between the friths of Clyde and Forth; and in 83 †, the last year of his command, he had penetrated to the foot of the Grampian mountains in the northern parts of Angus. From this time, during the remainder of the reign of DOMITIAN, and through the whole of the reigns of NERVA and of TRAJAN, a period of above thirty years, the Romans made no progress in the island. The northern parts of the province were ill defended, and the Caledonians, in that interval, recovered all that part of Scotland which AGRICOLA had gained; for, in the second year of HADRIAN, A. D. 120, when that Emperor built his *vallum* across the island, between Solway frith and the mouth of the Tyne, he considered the Roman Province as extending no further to the north than that rampart. “ Murum per octoginta
“ millia passuum primus duxit qui barbaros Romanosque divi-
“ deret.” *Vit. Hadr. Hist. Aug. Script.*

THIS interval, therefore, of more than thirty years, must have been a period of remarkable improvement to the savage Caledonians. Maintaining a constant intercourse with the Romans, not distinguished by extraordinary hostilities, and gradu-

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ally

* WHITAKER's Manchester, book I. chap. 7.

† Or 84; for the year is not certain. See HORSLEY, p. 48.

ally regaining a country in which they found the recent works of a polished people, they could not fail to acquire much knowledge in the arts. At the time, therefore, when ADRIAN built his rampart, A. D. 120, we know, almost to a certainty, that the inhabitants of Scotland, as far to the north as the Grampian mountains, understood and practised the art of constructing durable buildings with mortar. The forts or *castella* erected by AGRICOLA, which TACITUS* says were so strongly constructed as to resist the utmost efforts of the enemy to take them by storm, were now in the possession of the Caledonians. The Roman castella were circular, and sometimes square, inclosures, surrounded with a strong wall of stone, hewn into square blocks, and cemented with mortar. The space inclosed was sufficient to contain various buildings likewise of stone, barracks for the winter habitation of the troops, granaries for provisions, and sometimes baths. The form of these castella may be seen in the sculptures upon the Trajan column, and their construction may be learnt from VEGETIUS. The remains of a bath belonging to one of these castella, probably erected by AGRICOLA, were discovered, within these few years, at the village of Dalnoter, between Glasgow and Dumbarton. The Caledonians had witnessed the building of those structures, which were reared with the most perfect skill in military architecture, from materials which the country furnished in abundance. They were now in possession of the structures themselves. It is reasonable, therefore, to conclude, that they now learnt the art of constructing regular buildings with stone and mortar, and practised it, both for the purposes of defence and habitation; because the contrary supposition would do violence to all probability.

THE wall of ADRIAN, which was built in 120, and that of ANTONINUS PIUS, built, as HORSLEY thinks, in 140, were
both

* Vit. Agric. cap. 22.

both constructed solely of turf *. But they were defended by castella, placed at intervals of various distance, according to the nature of the ground. The wall of ANTONINUS ran across from Dumbarton on Clyde to Cramond on the frith of Forth, and was probably in the precise line of the castella built by AGRICOLA. It was at this period, and under the command of LOLLIVS URBICUS, the lieutenant of ANTONINUS, that the Romans made their farthest advances into the island of Britain. After the erection of this new vallum, which had probably been reared in the idea, that the country to the north of it was hardly worth securing, URBICUS marched to the northward, and finding, beyond his expectation, that the country, especially along the sea-coast, was open and fertile, he appears to have prosecuted his conquests as far north as Inverness. For this fact, we want indeed the authority of any Roman historian ; but the Geography of PTOLEMY, and the late discovered itinerary of RICHARD of Cirencester, prove, beyond all doubt, that there were Roman stations in the neighbourhood of Inverness ; and there is no other Roman general, but URBICUS, who, to the days of PTOLEMY, can be supposed to have passed the limits of AGRICOLA's conquests †. The most northerly Roman station, according to PTOLEMY, is the *πτερωτον στρατοπεδον*, or castra alata, which, in the itinerary of RICHARD, is termed Ptorotone. This, I think, there is every reason to believe to have been that fortified promontory, now called the Burgh of Moray ‡. At
any

* JULIUS CAPITOLINUS, in his life of ANTONINUS PIUS, mentions, that this Emperor excluded the barbarians from the Province, "*alio muro cespitio*," which proves that the former, viz. that of ADRIAN, was of the same materials.

† WHITAKER's History of Manchester, book L. chap. 3. § 1.

‡ Its shape corresponds entirely to the name of an encampment with wings. Such is the actual form of the promontory ; and although both STUKELEY and HORSLEY place the station of Ptorotone at Inverness itself, it will be observed, this is nothing more than conjecture. The itinerary of RICHARD gives no authority for that precise situation ;
for

any rate, it is certain there were several Roman stations in that neighbourhood, as Tueffis, Varis and Ptorotone, which is sufficient for our purpose. It is then evident, that, in the reign of ANTONINUS PIUS, and within a few years of A. D. 140, the date of his *vallum*, the Romans had fixed præsidia and built castella in the neighbourhood of Inverness, from which part of Scotland, there was an uninterrupted military road, as appears by RICHARD'S itinerary, to the Land's end in Cornwall. At this period, therefore, the inhabitants of this region of Scotland must have been acquainted, from the practice of the Romans, with the art of building with mortar. And, as the structure of those hill-fortifications demonstrates the ignorance of the builders of the use of that cement, the most complete evidence thence arises, that they were reared prior to the time above mentioned, that is, above sixteen centuries and a half ago.

BUT how far beyond that period we are to search for the date of those singular fortifications, still remains in doubt. All that we can, with certainty, conclude, is, that they belong to a period of extreme barbarism. They must have been constructed by a people scarcely removed from the state of savages, who lived under no impression of fixed or regulated property in land, whose only appropriated goods were their cattle, and whose sole security, in a life of constant depredation, was the retreat to the summits of those hills of difficult access, which they had fortified in the best manner they could. As the space inclosed was incapable of containing a great number of men, especially if occupied in part by cattle, it is presumable, that these retreats were formed chiefly for the security of the women

for the distance in miles between Ptorotone, and the preceding station Tueffis, is left blank in the itinerary, and the actual situation of Tueffis is likewise uncertain, HORSLEY fixing it at Nairn, and STUKELY at Ruthven on the Spey. All that is certainly known from RICHARD'S itinerary, is, that Ptorotone was the third Roman station beyond the Grampian mountains.—Since writing the above, it was a satisfaction to me to find, that General ROY, in his elegant map of Roman North Britain, has actually placed Ptoroton, or Ptorotone, at the burgh-head of Moray.

men and children of the canton, and of their herds. They could be defended by a few men, while the rest of the tribe were engaged with their enemies in the field.

IN the description I have given of the fortified hill of Dun-Jardel upon Loch-Nefs, I mentioned a Druidical circle upon the shoulder of the hill about fifty or sixty feet below the fortification; and hinted, that this circumstance might possibly afford ground for a conjecture with regard to the date of those extraordinary structures on the tops of hills.

THE religion of the Druids obtained in Britain long before the period of the Roman invasion; and it was probably introduced into the island by the first colony of Celtæ or Gauls who landed from the continent*. If, as is generally supposed, this island was actually peopled from Gaul, Druidism must have been the religion of its first inhabitants. I am disposed, however, to believe, that this island was inhabited of old by a race of men who knew nothing of the religion of the Druids, whose manners and mode of life were too barbarous to be compatible with that system, and who, in after times, adopted from those Druids their first ideas of civilization and improvement. The Druids, it is well known, were a very enlightened order of men; and they had the address to avail themselves of that character of wisdom and learning, in obtaining an absolute controul, not only in matters of religion, but in the civil government of the countries in which they were established. They cultivated the mechanic arts, and even the sciences of Medicine, Astronomy and Geometry, with considerable success. In short, no nation, among whom that system had become prevalent, could long remain in a state of barbarism. But, from all the ideas we can form

* THIS idea is not contradicted by the fact, of which we are assured by CÆSAR, *viz.* That the Druids of Gaul were sent over for instruction to Britain. This fact proves only, that the British Druids, in the solitude of the distant island of Mona, had made farther advances in the sciences at that time, than their brethren on the continent. CÆSAR indeed thence conjectures, that the Druidical system had been invented in Britain; but this conjecture has no other basis than the fact above mentioned.

form of the state of Caledonia, at the time when it was necessary to rear those hill-fortifications, there appears no probability that the inhabitants either lived under such a government as we know to have prevailed under the influence of the Druids, or had any acquaintance with those arts which it is certain they cultivated. Those buildings must, therefore, have been erected previously to the introduction of the Druidical system ; that is to say, in a period of time antecedent to the first visitation of this island by the Celtæ of Gaul.

THE Druidical circle upon Dun-Jardel lends its aid in support of this conjecture. If the fortification on the summit had been erected after the abolition of Druidism, it seems extremely improbable, that the builders of it would have neglected to employ the stones of this circle in rearing their fortification, (stones extremely well suited to the purpose, and quite at hand) when they have been at immense pains to carry up a prodigious quantity of stones from the very bottom of the hill for that work. It is not probable that they would have been restrained by any superstitious idea of reverence for the monuments of an extinguished religion. For Druidism, soon after its abolition, sunk into utter contempt, and the introduction of Christianity rendered the ancient superstitions impious and detestable. That this hill-fortification was erected in the times of the Druids, I have already shewn to be extremely improbable. We must, therefore, recur to the only remaining, and the most natural supposition, that it was reared in times antecedent to the introduction of that religion. And this supposition carries the date of this structure, and consequently of all the rest of the same nature, up to a period of antiquity far beyond all historical record, and connects them with a state of society in which the arts were as imperfect, the manners as barbarous, and the condition of life as lawless, turbulent and precarious, as among the rudest tribes of American savages.

Plate I.

FIG. 1.



FIG. 2.

CRAIG - PHADRICK.

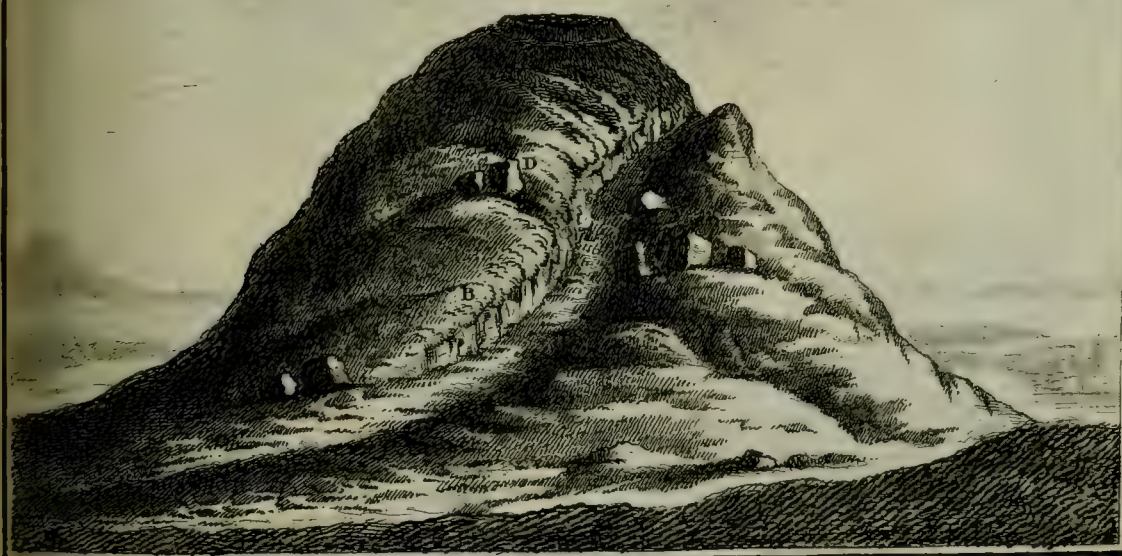


Fig. 1.

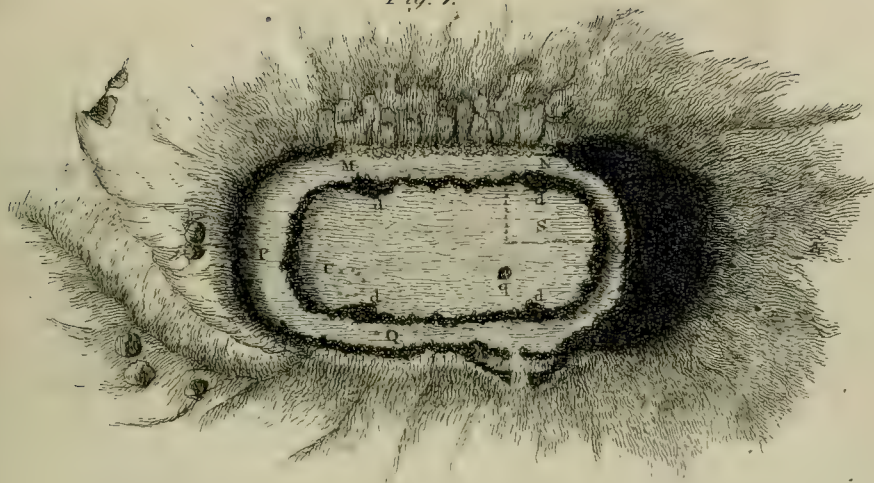
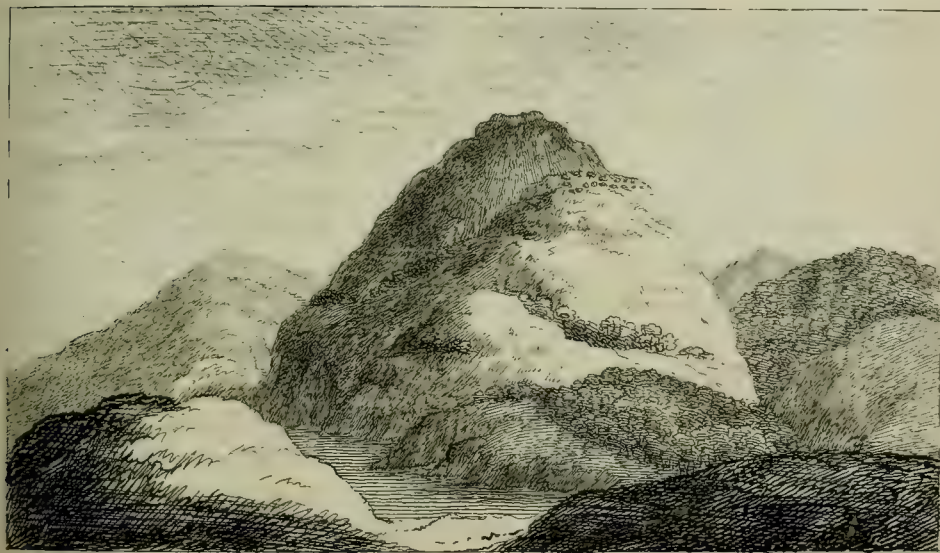


Fig. 2.



Dun-jardel

II. REMARKS on some Passages of the sixth Book of the ENEID.
By JAMES BEATTIE, LL. D. F. R. S. EDIN. and Pro-
fessor of Logic and Moral Philosophy in the Marischal College,
Aberdeen.

[Read by Mr DALZEL, Secretary, March 19. 1787.]

THE poetical beauties of VIRGIL's sixth book are great and many; and a most agreeable task it would be to point them out: but that is not my present purpose. Nor do I intend to draw a comparison of the sentiments of our poet with those of HOMER, concerning a future state. From HOMER, no doubt, VIRGIL received the first hint of this episode; but the evocation of the ghosts, in the eleventh book of the *Odyssey*, is not in any degree so striking, or so poetical, as ENEAS's descent into the world of spirits. Nor does the former exhibit any distinct idea of retribution. In it all is dark and uncomfortable. "I would rather, says the ghost of ACHILLES, be the slave of a poor peasant among the living, than reign sole monarch of the dead:" a passage blamed, not without reason, by PLATO, as unfriendly to virtue, and tending to debase the soul by an unmanly fear of death.

My design is, to give as plain an account as I can of the *theology* (if I may be allowed to call it so) of this part of VIRGIL's poem. And I shall make the poet his own interpreter, without trusting to commentators, or seeking unnecessary illustrations from PLATO, to whom VIRGIL, though he differs from him in many particulars, was indebted for the outlines of

the system, and who probably owed them to philosophers of the Pythagorean school.

THE learned Bishop WARBURTON has commented on this part of the *Eneid*. Many of his observations are pertinent, but some are fanciful; and in more places than one he seems to have misunderstood the author. His general position is, That what the poet says of Elysium and the infernal regions, we are to understand as nothing more than a figurative account of the mysteries exhibited in the temple of CERES at Eleusis; and that the poet meant in this way to tell us, that *ENEAS* had, like some other heroes and lawgivers of old, been initiated into those mysteries. This theory he supports very ingeniously, but not, I believe, to the satisfaction of many readers. I admit there are allegories in the book, as I shall have occasion to show; but that the whole is an allegory, or rather an allegorical representation of the Eleusinian allegories, I can no more suppose, than that the arrival at Carthage is an allegory, or the visit to *EVANDER*, or the combat with *TURNUS*, or any other of our hero's achievements. I consider this episode as truly epic, and as a part, though not a necessary part, of the poet's fable; and that he contrived it, first, that he might embellish his work with a poetical account of a future state, and secondly, and chiefly, that he might thence take an opportunity to introduce a compliment to his country, by celebrating the virtues of some of the great men it had produced. As these great men did not flourish till after the death of *ENEAS*, there were but two ways in which the poet could make him acquainted with them. One was, by causing some priest or soothsayer to prophecy concerning them; and the other, by so availing himself of the doctrines of pre-existence and transmigration, then taught in some of the schools, as to exhibit in their pre-existent state, such of the hero's posterity as there might be occasion for. He chose the latter method; and has so managed it, that we must acknowledge the choice to have been judicious.

As the chief thing I have in view is, to illustrate the moral and theological sentiments of my author, I need not take up much time, either in vindicating, or in apologizing for, his general fiction; I mean, his laying the scenery of a future state in the subterranean regions. That on the coast of Italy, in the neighbourhood of Cumæ, there should be a passage underground, leading to the rivers Acheron, Cocytus and Styx, and thence to Tartarus on the left hand, and Elysium on the right; that in this Elysium, though thus situated, there should be a sun and stars, and grassy plains, and delightful groves and rivers, and two gates, the one of ivory, the other of horn, opening into the upper world, at no great distance from the Cumæ above mentioned; and that in the subterranean spaces thus bounded, there should be different sorts of accommodation for all the shades or souls of the dead:—these, I say, are fables, which, as they cannot, according to our way of judging, be reconciled to probability, or even to possibility, we must endeavour to acquiesce in the best way we can. So, in reading OVID's story of Phaeton, if we would enter into the poet's views, and be suitably affected with his narrative, we must suppose, what we know to be absolutely impossible, that the sun is driven about the world in a chariot, which, though made of gold and silver, and dragged by real horses, and supported by nothing but air, yet passes along in a beaten highway, where the marks of the wheels are clearly discernible. Fables of this sort, however inconsistent with the laws of nature, when rendered by the art of the poet consistent with themselves, it is not our interest to criticize too minutely; especially if, like that now under consideration, they abound in sublime description and instructive lessons of morality. The fable then let us acquiesce in for a moment. Our dreams, while they last, we believe without inconvenience; and the scenery of this fable will not be more lasting than that of a dream.

As a sort of apology for the wildness of some parts of this fable, it may be remarked, that formerly at Cumæ, near which the Trojan fleet was now stationed, there lived a prophetess called the Cumean Sybil; that in her neighbourhood, encompassed with thick woods, there was a lake called Avernus, which emitted pestilential steams; that in the same parts of Italy there are many dreadful caverns, one of which is to this day called the Sybil's Grotto; and that for those who knew nothing of the real size of the earth, or the final destination of man, it was not altogether absurd to imagine, as all dead bodies return to the earth, that the subterranean regions might be the mansions of the ghosts or shades of human beings departed.

THE necessary sacrifices being performed, and ENEAS having found in the woods that golden bough which, being intended as a present to PROSERPINE, was to serve him as a passport through her dominions; the Sybil or priestess plunged into the cavern, calling to him to follow her, with his sword drawn in his hand. They went a great way through a lonely region, where there was no more light than one travelling in a wood receives in a cloudy night from the moon. At length they arrived at the entrance of the infernal world, where a number of terrible beings resided; Disease, Old Age, Fear, Famine, Poverty, and Death, and Labour, and War, and Discord; and such monstrous things as centaurs, gorgons, harpies and giants, one with three heads, and another with a hundred hands, and the chimera breathing fire, and the many-headed serpent of Lerna roaring hideously. By placing these at the entrance, the poet perhaps intended to signify, in the way of allegory, the horrors that accompany the near approach of death; or perhaps those many evils, real and imaginary, which we must all pass through in our way to the other world.

FROM this place to the river Styx was a region, in which the ghosts of those, whose bodies had not been honoured with the
rites

rites of sepulture, were obliged to wander in a melancholy condition for the space of an hundred years, before they could be permitted to pass the river, or appear before any of the infernal judges. Here ENEAS met with his old pilot PALINURUS, who, in their last voyage, having fallen overboard in the night, and swam to the main land of Italy, was there murdered by the natives, who did not give themselves the trouble to bury him, but threw his body into the sea. He begged ENEAS to take him under his protection, and procure him a passage over the Styx. "It cannot be, said the Sybil; you must have patience. In the place where you were murdered, there will soon be prodigies, which will induce the natives to perform your funeral rites, and call a promontory after your name; and then you may pass the river, but not before." PALINURUS acquiesced; well pleased to hear that such honours awaited him.

To inculcate this doctrine, that the soul would suffer for some time in another world, if the body were not decently buried in this, and that the neglect of the funeral ceremonies is offensive to superior beings, was a very warrantable fraud in the lawgivers of Greece and Egypt; as it would no doubt make the people attentive to a duty, whereof we find that savage nations are too apt to be forgetful.

OUR two adventurers were now approaching the river, when Charon the ferryman, alarmed at the sight of a living man in complete armour, called to the Trojan to stop, and give an account of himself. The Sybil pacified Charon, by declaring the name and quality of her fellow-traveller, and showing the golden bough. They were then ferried over; and the three-headed dog Cerberus, preparing to attack them, was quieted with a cake which the priests had got ready for him, and which he had no sooner swallowed than he fell fast asleep.

WHAT could have given rise to this fable of Charon and his boat, it is not very material to enquire. Mythological writers have

have said, That the Greeks learned it from the Egyptians, which is indeed probable enough; that the Egyptians framed both this, and some other fables relating to the dead, from certain customs peculiar to their country; that in particular there was, not far from Memphis, a famous burying-place, to which the dead bodies were conveyed in a boat across the lake Acherusia; and that Charon was a boatman who had long officiated in that service. The learned Dr BLACKWELL says, in his life of HOMER, that, in the old Egyptian language, *Gharoni* signified ferryman.

THE travellers had now before them a region which the poet calls *lugentes campi*, extending from the other side of the Styx to the road that leads to Elysium on the right hand, and that which terminates in Tartarus on the left. These melancholy plains must not be confounded with Tartarus. The latter is a place of eternal torment, prepared for those who, in this world, had been guilty of great crimes; for there, says the poet, “*Sedet, æternumque sedebit infelix Theseus.*” The former, though an uncomfortable region, is not a place of endless punishment, but a sort of purgatory, in which all those souls that are not consigned to Tartarus, are doomed to undergo certain purifying pains, to prepare them for Elysium. These pains are more or less severe, and of longer or shorter duration, according to the degree of guilt committed in the upper world. The souls, on passing the Styx, appear before the judge Minos, who summons a council, either of ghosts or of infernal deities, but whether as a jury, or as witnesses, we know not; and having informed himself of the lives and characters of those who are brought before him, allots to each a suitable mansion in this purgatory.

THE souls thus disposed of, are—*first*, those of good men, who, after undergoing the necessary pains of purification, pass into Elysium, where they remain in a state of happiness for ever; *2dly*, of those who have been of little or no use to mankind;

kind ; 3dly, of those who have been cut off by an untimely death, so that their real characters could not be exactly ascertained ; 4thly, of those who, though guilty of crimes, had not committed any thing very atrocious ; and, lastly, of those whose crimes, though atrocious, were considered as the effects, rather of an unhappy destiny, than of wilful depravation.

THAT the souls of good men, who were to have an eternal abode in Elysium, were previously obliged to undergo purgation by suffering, is not expressly declared, but may be inferred from what ANCHISES says, "*Quisque suos patimur manes*:" "every one of *us* undergoes what is inflicted on him by his "*manes*;" that is, by those deities of the nether world who were the dispensers of expiatory punishment. This is the original, or at least the most usual sense of the word *manes*, which, however, sometimes denotes metonymically the infernal regions in general, and sometimes, but more rarely, the souls or shades who inhabited those regions. In Tartarus, it does not appear that the Manes had any thing to do. The dispensers of punishment in that dreadful place were Tisiphone and her sister-furies. The Manes must have been a gentler sort of beings. Some derive the word from *manus* or *manis*, which they say (on what authority I know not) is an old adjective signifying *good*. The invocations of the Manes practised at funerals, the altars that were erected to them, and those monumental inscriptions which began with the words *Dis Manibus*, were all, no doubt, intended as acts of worship, or as compliments, to these deities, and supposed to incline them to mercy in their treatment of the persons deceased, whose souls were now in their hands in purgatory. HORACE tells us, that the Manes, as well as the gods above, might be rendered placable by song—"Carmines di superi placantur, carmine manes." But the furies were inexorable and merciless—"Nesciaque humanis precibus mansuescere corda." And I do not find that worship, or any other honours, were except by witches*, paid them, though to mother Midnight, whose daughters:

* HOR. Sat. I. 8. v. 33.

daughters they were, sacrifice was occasionally performed. OVID says indeed, that they relented on hearing the song of Orpheus, but assures us it was for the first time. VIRGIL, in his account of that affair, says only, that they were astonished.

HERE I cannot but remark how absurd it is for *us* to begin an epitaph with the words *Dis Manibus*, or the letters *D. M.* which oftener than once I have seen on a modern tombstone. Such an exordium may be classical ; but, in a Christian church-yard, an invocation to Proserpine would not be more incongruous. ADDISON did well, when he advised the writers of his time not to sacrifice their catechism to their poetry.

I SAID, that the Manes seem to have had nothing to do in Tartarus. I am not ignorant, however, that RUEUS and the common Dictionaries affirm, that the word sometimes denotes the furies, and quote as an authority, “ Ignoscenda quidem, scirent si ignoscere manes.” But this is not sufficient authority. That verse of VIRGIL relates to Orpheus looking behind him, when conducting his wife to the upper world ; a fault, or infatuation, which was to be punished, not by the scourge of the furies, but by calling back Eurydice to the shades below ; and which the Manes, however placable, could not pardon, because it was a direct violation of the treaty with Proserpine.

It is somewhat difficult to understand distinctly what the ancients meant by the words *animæ*, *umbræ*, *simulacra*, which, in this discourse, I call *ghosts*, *shades* or *souls*. We know, that man consists of a body and a soul, a material and an incorporeal part ; the one, like all other bodies, inactive, the other the source of life, motion and intelligence. But, on comparing the general doctrine of this sixth book with a passage in the fourth Georgic, and with the eleventh of the Odyssæy, we find, that our poet, following in part the opinions of PYTHAGORAS and PLATO, and partly too the representations of HOMER, supposed man to consist of three substances ; *first*, a vital and ac-

tive

tive principle, derived either from the Deity himself, or from that universal spirit whom he created in the beginning, who animates all nature, and of whom the vital principle of brutes is also, according to VIRGIL, an emanation; 2dly, a shade or ghost, *umbra*, *anima*, *simulacrum*, or *εἶδωλον*, as HOMER calls it; and 3dly, a body. At death, the vital principle was re-united to that universal spirit whereof it was originally a part; the body was burned or buried, and returned to the earth whence it came; and the shade or ghost went to the nether world, and appeared before Minos or Rhadamanthus, who assigned it such a mansion of happiness, of torment, or of expiatory suffering, as the person's behaviour on earth had merited, or his circumstances with respect to pollution or purity required. These shades or ghosts were so far corporeal as to be visible, but could not be touched; they retained the same appearance their bodies had before death; they had reason and speech and consciousness, and a remembrance of their past lives; they could be happy or unhappy; retained all the passions and affections of humanity; and were capable (such of them at least as had not been atrocious criminals) of being purified from the pollutions of guilt by the operation of air, fire and water.

THAT part of the *lugentes campi* which ENEAS first passed through, after crossing the Styx, was peopled by the shades of infants, of persons who had suffered death by a false accusation, and of those who had taken away their own lives. These are all placed in the same neighbourhood, probably because, having been cut off, as we say, before their time, they had not had the means, while on earth, of displaying their character in its full extent. This, however, is but conjecture; for the poet only mentions the circumstance, without assigning a reason. The self-murderers, who occupy this district, are termed *insentes*, innocent or harmless; an epithet which the commentators do not understand, or at least do not see the propriety of in this place. VIRGIL, we are sure, did not mean to insinuate, that

self destroyers in general are guilty of no fault; for he places even these *infantes*, who in respect of others were comparatively innocent, in an uncomfortable situation, and says, that they would now return to the earth if they could, and willingly submit to poverty, and those other evils, which when alive they thought insupportable. By the word *infantes*, therefore, as here applied, I understand such unhappy persons as had destroyed themselves, without being chargeable with any other great wickedness. Had they been guilty of impiety, injustice, want of natural affection, or any gross immorality, they would, according to our author's plan of retribution, have been consigned to everlasting punishment in Tartarus. But as we find them in a state of expiatory suffering, and characterised by this epithet, we must, I think, suppose, that the poet here speaks of that self-destruction, which, being partly the effect of infirmity, was, in his judgment, the object of pity as well as of disapprobation.

THE Trojan and his guide were now arrived at that part of the melancholy plains, where the country, if I may call it so, seemed to open into a wider extent. Here was a district, where, in a myrtle grove, were wandering the shades of unhappy lovers. Here ENEAS met with DIDO, who had rejoined her husband SICHEUS; and here he saw several others, some of whom, by the by, had led such lives on earth as would seem to deserve a severer doom than that of VIRGIL's purgatory.

ADJOINING to the grove of lovers, and at the furthest extremity of these regions, was a province inhabited by deceased warriors. Here he found several of his old acquaintance, who were glad to see him, and converse and walk with him, and curious to know the occasion of his coming. The Grecian ghosts knew him likewise, and fled from before him, as they had been accustomed to do in the Trojan war. Here he saw the shade of his brother-in-law DEIPHOBUS, in the same mangled condition in which his body had been left by the Greeks in the
night

night of the burning of Troy. A long conversation ensued between the two friends, which was at last interrupted by the priestess, who told ENEAS that he had no further time to lose. Be not angry, said DEIPHOBUS ; I shall go away, return to my darkness, and there complete my term of penance.

Difcedam, explebo numerum, reddarque tenebris.

The words *explebo numerum* are variously interpreted ; but the sense is probably what is here given. RŪEUS is inclined to explain it thus, “ Be not angry, great priestess, I shall just wind “ up the last period of my discourse, and then return to my “ darkness ;” as if the poor mangled ghost of DEIPHOBUS had been ambitious to distinguish itself at this time as a rhetorician, and well skilled in the art of rounding a period. DRYDEN understands the passage as I do. SERVIUS hints at the same interpretation, but seems to prefer another.

THE two travellers having passed through the melancholy plains, were now come to a place, where one road went off to the left, and another to the right ; the former leading to Tartarus, the latter to Elysium. They were going to Elysium on a visit to ANCHISES : but before they struck off to the right, the priestess took this opportunity to describe Tartarus, the gates of which were in view, but which ENEAS could not enter, as they were never opened but for the reception of those wicked souls, whom the judge Rhadamanthus, after making them confess the crimes they had committed in the upper world, thought proper to condemn to eternal punishment. When this dreadful sentence was passed, they were seized on by Tisiphone and the other furies, the adamantine gates opened with a tremendous sound, and the criminals were thrown into an immense dungeon, stretching downwards twice as far as from hell to heaven.

THE description of Tartarus is wrought up in a style of terrible sublimity, such as never was equalled by any other poet, except by MILTON, in the first and second books of *Paradise Lost*. In the intrinsic grandeur of his images, the English poet may be thought to have excelled the Roman; but in one respect the Roman has the advantage. By means of a more musical language, he has been enabled to embellish his narration with a sonorous magnificence of harmony, whereof the English tongue, even when modulated by MILTON, is not susceptible.

THE mouth of the Tartarean gulf was encircled with three walls so strong, as to be proof against every assault of men or gods; and these walls were surrounded by Phlegethon, a river of tempestuous flame. Sleepless, before the gate, day and night, and full in ENEAS's view, sat the fury Tisiphone in bloody attire. From within issued such an uproar of terrifying noises, that the hero, though at a distance, heard it with horror; the cries of the tormented, the sound of the scourge, the crash of iron engines, and the clanking of chains dragged along. Tell me, said he, O virgin, what clamours, what punishments, are those; and for what crimes they are inflicted. This gives the priestess occasion to describe what was passing in the regions of torment; with which Hecate had made her acquainted, when she gave her the superintendence of the groves of Avernus. The persons there punished had all perpetrated enormous crimes; among which are reckoned, acts of impiety, want of natural affection, cruel treatment of parents, the defrauding of clients or dependants, and the hoarding up of wealth to the injury of friends and relations. Here too adultery is punished, even though the criminal should have already suffered death for it in the upper world. Other crimes here punished are, rebellion, incest, the various sorts of injustice and treachery, the venality of lawgivers, subversion of the liberties of our country, sacrificing the public good to private interest, and

and many other forms of wickedness, whereof the Sybil declares it was impossible for her to give a particular enumeration.

THE punishments are various. Of one enormous offender, the entrails are continually devoured by a vulture, and continually growing to be again devoured; an apt emblem to express the pangs of a guilty conscience, and which puts one in mind of the never-dying worm mentioned in Scripture. Some are in the eternal apprehension of being crushed by a black rock, which hangs over them, and seems to be every moment beginning to fall. Some are perpetually employed in rolling a huge mass of stone; some are stretched out on a whirling wheel; and some, agonising with eternal hunger, have a sumptuous banquet set before them, which they no sooner attempt to touch, than a gigantic fury starts up, brandishing a torch, and denouncing vengeance in a voice of thunder.

THERE is nothing in VIRGIL more explicit than the account of Tartarus; and I know not why it has been so generally misunderstood. DR WARBURTON says, in one place, that ENEAS saw the fights of Tartarus at a distance, and, in another, that ENEAS passed through Tartarus. In fact, he did neither. He could not pass through without entering; and this, we are told, was to him impossible: “Nulli fas casto sceleratum insistere limen.” And though he had been permitted to enter, he could not pass through, without first crossing a river of fire, and then descending into an immense gulph, twice as deep beneath the level of the other regions of darkness, as those are remote from heaven. It was equally impossible for him to see from a distance what was doing in such a gulph, even though the gate that led to it had been open, which, however, at this time, happened to be shut. “You see, said the Sybil, what a centinel sits without in the porch, (meaning Tisiphone); another, still more dreadful, has her station within;” which, as he could not see it, she informs him is a huge serpent, or hydra, with fifty heads. An opening of the gate is indeed
mentioned.

mentioned, which RUEUS understands to have taken place at the very time when the Trojan and the Sybil were looking at it. But that is a mistake. The Sybil only tells her companion, that, when Rhadamanthus has made the criminals confess their guilt, then at length (*tum demum*) the gate opens for their reception into the place of torment. It is strange that RUEUS and Dr WARBURTON did not see that this is the obvious import of the words of VIRGIL; and that, if we do not understand them in this sense, the passage must appear confused, if not ungrammatical. In a word; of the inside of Tartarus the Trojan hero saw nothing; he saw the outside only, the walls, the gates, the tower of iron, &c. and these he saw at some distance. What was passing within he learns from the Sybil's information.

"AND now, says she, let us be going. Yonder, on the right hand, is the palace of Proserpine, where, in the vaulted porch that fronts us, we are commanded to deposit the golden bough." This ceremony ENEAS performs, after having sprinkled himself with pure water; which was customary with those who made offerings to the gods.

THEY then went onward to Elysium, the gay scenery of which, immediately succeeding the gloom of purgatory and the horrors of Tartarus, is so charming, that every reader feels himself refreshed by it. Here were groves, and plains, and meadows, clothed with perpetual verdure, the abodes of tranquillity and joy, and illuminated by a sun and stars of the most refulgent beauty. Here were feasting, and dancing, and music, and poets accompanying their verses with the harmony of the lyre. Here those warlike exercises were renewed, in which the heroes while on earth had so much delighted; and here were horses, and chariots, and arms, and every thing that could gratify an heroic mind. It must be owned, that all this is very inadequate to the desires and the capacity of an immortal soul:

soul: but VIRGIL had heard of nothing better; and it was impossible for him to describe what he could not conceive.

IN this Elysium, which, with all its imperfection, is, as well as the infernal world, founded on the best ideas of retributive justice that could be expected from a pagan, the poet places, in a state of endless felicity, “ the shades of the pure and the
“ pious; of heroes who have died in defence of their country;
“ of ingenious men who have employed their talents in adorn-
“ ing human life with elegant arts, or in recommending piety
“ and virtue; and of all who, by acts of beneficence, have
“ merited the love and the gratitude of their fellow-creatures.”

To a company of these happy beings, who had flocked round the two strangers, and especially to the poet MUSEUS, whom she knew, the Sybil addressed herself, desiring to be informed where ANCHISES resided. We have no certain habitations, returned the poet; we wander about, and amuse ourselves, wherever we please; but follow me to yonder rising ground, and I shall put you in a path that will conduct you to him.

SOME writers blame VIRGIL for not making ENEAS find HOMER in this part of Elysium; and insinuate, that the Roman poet must have been both invidious and ungrateful, in neglecting such an opportunity of doing honour to his great master, to whom he owed so much. Those critics do not consider that ENEAS was dead an hundred years before HOMER was born. Our poet has been censured for a *supposed* anachronism, in making ENEAS and DIDO contemporary; and here he is found fault with for having judiciously avoided a *real* anachronism.

IT chanced that ANCHISES was at this time in a remote valley, reviewing, in their state of pre-existence, some of his posterity, who were afterwards to distinguish themselves in the Roman republic. When he saw his son advancing towards him, he held forth both his hands, gave him an affectionate welcome, and wept for joy. The hero would have embraced his father;

ther; but found that the shade, though visible, eluded the touch.

AFTER a short conversation, ENEAS happening to see, in a grove through which a river was flowing, an innumerable multitude of human beings flying about, asked his father who they were, and what river it was. The river, said he, is Lethe, of which those souls are taking a draught, being about to return to the upper world, in order to animate new bodies. Is it to be imagined, exclaims ENEAS, that souls should ever leave this happy place, and go back to the imprisonment of the body, and all the wretchedness of mortality? I will explain the whole matter to you, replies ANCHISES.

KNOW, then, that all the parts of this visible universe, the heavens, and earth, and sky, the sun, moon, and stars, are, like one vast body, animated by an universal spirit, whereof the souls, or vital principles, of all animals, of men and beasts, of fishes and fowl, are emanations. This vital principle is, in every animal, the source of sensation and motion; but, from the influence that the body has over it, becomes subject to inordinate passions, and forgetful of its heavenly original. The soul of man, in particular, (for nothing further is said of the other animals) contracts, while shut up in the dark prison of the body, a degree of debasement which does not leave it at death, and from which the sufferings of a subsequent state of purgation are necessary to purify it. These are of different kinds and degrees, according to the different degrees and kinds of guilt or impurity which the soul has contracted. Some souls are exposed to the beating of winds, some are washed in water, and some purified by fire. Every one of us (says ANCHISES, including himself) suffers his own peculiar pains of purification. Then we are sent into this vast Elysium, and a few of us remain in the eternal possession of it*. The rest continue
here,

* I suppose the words *Et pauci lata arva tenemus*, to be a parenthesis; which, in my opinion, clears the text of all obscurity. By the change of the person, in the four last lines

here till, by the air and tranquillity of the place, they have entirely got the better of the impurity contracted in the world, have had every impression of the pains of purgatory worn out, and are restored to their original simplicity of nature. Thus refined, they are, at the end of a thousand years †, summoned by a divine agent, or god, to meet in one great assembly, where they drink of Lethe to wash away remembrance, and then, in compliance with their own inclination, are sent back to the earth to animate new bodies.

HAVING ended this account, ANCHISES, with his son and the Sybil, passes to a rising ground, and points out, in a state of pre-existence, a procession of Roman heroes, who were in due time to descend from him; briefly describing their several characters, in a most sublime strain of poetical prophecy.

I SHALL subjoin a few remarks on the concluding scene of this noble episode;—on the gates of horn and ivory. These gates have given no little trouble to critics, both ancient and modern; who, after all, seem to have been not very fortunate in their

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conjectures.

lines of the speech,—*Has omnes,—volvete,—incipiant,—revivant*, it appears, that ANCHISES does not include himself among those who were to return to the world; which ascertains sufficiently the import of *tenemus*. The learned RUVES construes the passage in a way somewhat different; but his general account of the poet's doctrine differs not essentially from mine.

† MORE literally, “When they have rolled the wheel, or circle, for a thousand years;” that is, when the revolution of a thousand years is completed. For this interpretation we are indebted to SERVIUS, who tells us further, that this singular phrase was taken from ENNIUS. Anciently perhaps *rota* might mean a *circle*, (as well as a *wheel*,) and poetically a *year*; so that, in ENNIUS's time, *volvete rotam* might be a figurative phrase of the same import with *annum peragere*, *to pass a year*. The original meaning of *annus* is a *circle*, whence the diminutive *annulus*, a *ring*. The same reference to the circular nature of the year, may be seen in the Greek *ἐναυτος*, which VIRGIL certainly had in his mind when he wrote, “*Atque in se sua per vestigia volvitur annus*.” When this is attended to, our author's use of the phrase in question will appear not so harsh as it might otherwise be thought to be, and not at all too figurative in this very solemn part of the poem.

conjectures. This is owing, not to obscurity in the poet, but to the refinement of those interpreters, who mistook a plain passage for a profound allegory, and were determined to find a secret meaning in it. The gate of ivory, say they, transmits false dreams, and that of horn true ones; and ENEAS and his companion are dismissed from Elysium, and let into the upper world, through the ivory gate. What can this imply, but that the poet meant to insinuate, that every thing he had said concerning a state of future retribution, was nothing more than a fallacious dream? And, in support of this conjecture, they generally quote from the Georgic three verses to prove, that VIRGIL was in his heart an Epicurean, and consequently disbelieved both a future state and a providence. The verses are—
 “Felix qui potuit rerum cognoscere causas, Atque metus om-
 “nes, et inexorabile fatum, Subjecit pedibus, strepitumque
 “Acherontis avari.”

Now, in the *first* place, it does not appear to me, that these lines can prove their author ever to have been an Epicurean, or that he meant to say more than “Happy is the man whose
 “mind philosophy has raised above the fear of death, as well
 “as above all other fears.” For, in the Georgic, he not only recommends religion and prayer, which Epicureans could not do consistently with their principles, but again and again asserts a providence; and, in terms equally elegant and just, vindicates the Divine wisdom in establishing physical evil as the means of improving and elevating the mind of man. But does he not, in his sixth eclogue, give an account of the formation of the world according to the Epicurean theory? He does; and he makes it part of the song of a drunkard: no proof that he held it in very high esteem.

BUT, *2dly*, Supposing our poet’s admiration of LUCRETIVUS might have made him formerly partial to the tenets of EPICURUS, it does not follow that he continued so to the end of his
 life,

life, or that he was so while employed upon the Eneid. The duties of religion, and the superintending care of providence, are by no other Pagan author so warmly enforced as in this poem; and the energy with which, in the sixth book, and in one passage of the eighth, (v. 666.) he asserts a future retribution, seems to prove, that he was so far in earnest with regard to this matter, as to believe, that it was not, as the Epicureans affirmed, either absurd or improbable.

LET it be remarked, in the *third* place, that no poet ever thought of so preposterous a method of pleasing and instructing his readers, as first to employ all his skill in adorning his fable, and then tell them, that they ought not to believe a word of it. The true poet's aim is very different. He adapts himself to the opinions that prevail among the people for whom he writes, that they may the more easily acquiesce in his narrative; or he is careful, at least, to make his fable consistent with itself, in order to give it as much as possible the *appearance* of seriousness and truth. *We* know, that the scenery of the sixth book is wholly fictitious; but the Romans did not certainly know how far it might be so: founded as it was on ancient tradition, which no history they had could overturn; and on philosophical opinions, which they had never heard confuted, and which, where Revelation was unknown, might seem respectable, on account of the abilities of PYTHAGORAS, PLATO, and other great men who had taught them.

To which I may add, *4thly*, as an argument decisive of the present question, That if VIRGIL wished his countrymen to believe him to have been *not* in earnest in what he had told them of a pre-existent and future state, he must also have wished them to understand, that the compliments he had been paying to the most favourite characters among their ancestors were equally insincere; and that what he had said of the virtues of CAMILLUS, BRUTUS, CATO, SCIPIO, and even AUGUSTUS himself, was altogether visionary, and had as good a right to a passage

through the ivory gate, as any other falsehood. Had OCTAVIA understood this to be the poet's meaning, she would not have rewarded him so liberally for his matchless encomium on the younger MARCELLUS. Had this indeed been his meaning, all the latter part of the sixth book would have been a studied insult on AUGUSTUS, and the other heroes there celebrated, as well as on the whole Roman people. Strange, that the most judicious writer in the world should commit such a blunder in the most elaborate part of a poem which he had consecrated to the honour of his country, and particularly to that of his great patron AUGUSTUS!

WE must therefore admit, either that VIRGIL had lost his senses, or, which is more probable, that, in sending ENEAS and the Sybil through the ivory gate, he intended no sarcastic reflection either on his country or on his poetry. In a word, we must admit, that, in this part of his fable, he was just as much in earnest as in any other; and that there was no more *joke* in ENEAS's *ascent* through the gate of ivory, than in his *descent* through the cave of Avernus. How then are we to understand this adventure of the gate? I answer, By making the poet his own interpreter, and not seeking to find things in his book which we have no good reason to think were ever in his head.

IN the nineteenth book of the *Odyssey*, Penelope, speaking of dreams, says to her nurse, that there are two gates by which they are transmitted to us; one made of horn, through which the true dreams pass, and the other of ivory, which emits false dreams. This thought HOMER probably derived from some Egyptian custom or tradition, which one might discuss with many quotations and much appearance of learning; and this, no doubt, gave VIRGIL the hint of the passage now before us. But VIRGIL's account differs from HOMER's more than the commentators seem to be aware of. HOMER does not say in what part of the world his gates are; VIRGIL's are in Italy, not far from Cumæ, and are said to be the outlet from
Elysium

Elysium into the upper world : a wild fiction no doubt, but not more wild than that of making the cave of Avernus the inlet from the upper world into the nether. HOMER's gates are the gates of dreams ; VIRGIL calls his the gates of sleep. The former are not said to transmit any thing but dreams ; of the latter, one transmits dreams, and the other *real ghosts* or *shades*. For thus, though all the commentators are against me, I must understand the words *umbris veris* ; because in VIRGIL *umbra* often signifies a *ghost*, but never in him, nor in any other good writer, (so far as I know) a *dream*. If it be asked, what ghosts they were that used to pass this way ; the answer is easy : they were those who, after having been a thousand years in Elysium, and taken a draught of Lethe, were sent back to the upper world to animate new bodies. If again it were asked, whether such beings might not be of so subtle a nature as to work their way into the upper world without passing through a gate ; I should answer, that visible substances, which might be purified by fire, or washed in water, and could not get over the river Styx but in a boat, must be so far material at least, as to be capable of confinement, and consequently of being set at liberty.

THE *falsa insomnia* that go out by the ivory gate may mean, either *deceitful dreams*, or *dreams in general*, that is, unsubstantial things, as opposed to realities ; which last I take to be the preferable signification. Be this, however, as it will, ENEAS and the Sybil were neither ghosts nor dreams, but human flesh and blood ; and could no more be supposed to partake of the qualities alluded to in the *name* of the gate by which ANCHISES dismissed them, than a man is supposed to be lame for having passed through Cripplegate, or than the Lord Mayor of London, by entering in procession through *Temple-bar*, is supposed to have become a better churchman than before, or a better lawyer. Through one or other of the gates of sleep the Trojan and his guide must pass, or they never could return to the upper world.

world at all : and that gate the poet probably made choice of, which first occurred to him ; and that probably would first occur which founded best in his verse : or perhaps one might say, in the way of conjecture, that he thought fit to open the ivory gate, because the other, being appropriated to the purified ghosts, might not be so well suited to mere mortals. This is certain, that, though the ablative *eburna* stands very gracefully in the 898th line, the ablative *cornea* could not ; because, being the foot *amphimacer*, it can have no place in a regular hexameter.

As to the analogy that some critics have fancied between horn and truth, and between falsehood and ivory, it is so whimsical, and so absurd, that I need not mention it.

AND now, by removing the mist of allegory from VIRGIL's gates, I flatter myself, that I have made these verses somewhat more intelligible than they have been generally supposed to be ; that I have proved the latter part of this episode to be consistent with the rest of it ; and that I have vindicated a favourite author from the heavy charges of impiety and ill-manners, whereof, however repugnant to his general character, it would not be easy for those to clear him who follow the common, though less obvious, interpretations.

III. *An ESSAY on RYTHMICAL MEASURES. By WALTER YOUNG, M. A. F. R. S. EDIN. and Minister of the Gospel at Erskine.*

[*Read by Mr JOHN ROBISON, Dec. 18. 1786.*]

MAN is formed to derive pleasure from a variety of different sources. Many of his pleasures are communicated by the channel of the external senses. Each of these has particular classes of objects that are suited to its gratification; and these, being diffused in great abundance through the works of nature, or framed by the art and ingenuity of men, become to him a source of frequent and diversified enjoyment.

THE pleasures which we receive through the senses of seeing and of hearing have ever been accounted of a nobler and more dignified nature than those which we receive by means of the other senses. They are intimately connected with, and seem, in a great measure, to depend upon, certain higher faculties of human nature, which have sometimes been called internal senses. A sensibility to them is possessed by different men in very different degrees, and confers upon some men a real superiority to others: The inferior animals do not appear to be, in any degree, possessed of it. It is susceptible of cultivation and improvement. The man, therefore, who possesses it in a high degree, whilst he has an exquisite enjoyment of all the pleasures which are peculiar to those senses, derives, at the same time, an additional satisfaction from the flattering consciousness, not only that he is exalted above the inferior animals, but that he is
more

more perfect in his kind, and more highly improved, than many who belong to his own species. Accordingly, these pleasures have, in all ages, been sought after with eagerness. Men of the greatest abilities have employed themselves in tracing out their nature, investigating the different internal senses upon which they depend, and discovering the various objects that are suited to communicate them. The greatest efforts of human ingenuity have been directed to obtain these objects, and to present them in their most perfect state.

AMONG the internal senses upon which these pleasures are found greatly to depend, the perception of order and proportion seems to have a principal place. Order and proportion are generally discovered, in a certain degree, in every thing that communicates immediate pleasure, either to our sight or hearing. When, from any particular circumstance, they happen not to be perceived, the pleasure is always greatly abated; in some cases it is altogether destroyed. That some kind of arrangement and proportion of parts is essential to every thing which is accounted beautiful, is generally acknowledged. Less doubt can be entertained with regard to the objects of hearing. It is an established fact, that no sounds can give great pleasure to the ear, unless they are related to one another according to certain proportions, and are disposed in a certain order. It is equally established, that when sounds in succession are so related, the pleasure which they afford is very imperfect, unless their respective durations are regulated according to certain measures. Mankind are greatly diversified with regard to the power which they possess of perceiving these relations. Some men have that power in a much higher degree than others. Some men have a very nice perception of these relations in one class of objects, while they seem to be scarcely sensible of them in other classes. These differences amongst men are undoubtedly owing in a great measure, to habit and cultivation. They seem,

seem, however, to depend also, in a considerable degree, upon natural constitution.

I HAVE observed, that, in an agreeable succession of sounds, order and proportion take place in two different ways. Upon the one depends what is called the tone of the several sounds, or the relation which they bear to one another with respect to acuteness and gravity; upon the other depends what is often called their rhythm, cadence or measure. The latter of these is probably the most important. It seems to be indispensably required in every agreeable succession of sounds. A series of notes, proportioned in tone with the utmost nicety, and arranged with the greatest art, if no measure or proportional duration is observed in them, will communicate no pleasure, but, on the contrary, will create disgust. On the other hand, a series of sounds justly proportioned in duration, and artfully disposed, will always give pleasure, although every one of them should be expressed in the same tone, and even although they should be expressed in different tones, the proportions of which cannot be perceived by the ear. The beating of a drum is agreeable to the ear, and sometimes has a considerable effect upon the mind. The syllables which compose words differ in length according to certain proportions, which may be felt by the ear. Words, therefore, may be arranged in rhythm. When this arrangement is made with art, the rhythm is agreeable, even when it is expressed in the tones of speech in which no musical proportion is perceived. Again, though men possess, in different degrees, the power of feeling the proportional duration of successive sounds, and of relishing an agreeable rhythm, there is perhaps no man altogether destitute of it. On the other hand, mens power of perceiving the musical relations of sounds, and of relishing an artful combination of them, is much more diversified. The differences among them in this respect are wider and more striking. In some men, that power is scarcely discernible, who nevertheless may be able to judge of rhythm

with accuracy, and to enjoy it with sensibility. From this circumstance, too, we are led to conclude, that of these two powers, that by which we perceive and enjoy rhythm is of greatest importance to our gratification.

TONE is the province of the musician alone. Rhythm is equally the province of the musician and the poet. It is also, in some degree, an object of attention to the orator and prose writer. Although the general principles and foundations of rhythm, as it takes place in the works of these different artists, may be nearly the same, the particular application of these, and the extent to which it is carried by each of them, are different. It may accordingly be distinguished into three kinds, *viz.* musical, poetical and prosaic.

It is proposed, in the following Essay, to endeavour to investigate some of the leading principles of the two first kinds of rhythm, the musical and the poetical, and afterwards to subjoin some additional remarks and illustrations upon each of them.

AMONGST the ancients, music was seldom or never used but as an auxiliary to poetry. Its rhythm, therefore, was regulated, in a great measure, by that of the poetry to which it was adapted. Amongst the moderns, too, music and poetry are frequently united; and by this union their greatest effects are produced. As, however, music has been greatly cultivated and improved by the moderns, it is enabled also to subsist alone, and in that situation to produce very pleasing effects. In this separate state it will be proper to consider it at present. And here it will readily occur, that variety, within certain limits, is necessary to musical rhythm. In poetry, the proportion in duration of single contiguous sounds seldom exceeds that of two to one. This proportion does not admit of great variety. When a poem, however, is recited, the attention of the hearer is chiefly engaged by the sentiments, the images and the diction. The rhythm is frequently considered only as an accidental grace, which we are led by habit to expect in every composition.

tion that bears the name of poetry. In music, on the other hand, a principal part of the pleasure to be communicated must depend upon the rhythm; and therefore in music other proportions in duration, besides that of two to one, must be admitted.

IN order then that these proportions may be felt, and that uniformity may be perceived amidst this variety, it is necessary that the duration of the successive sounds be regulated according to some fixed standard or measure, which may be obvious to the hearer. This standard must be a determined portion of time, of which every sound must be either an aliquot part or a multiple.

TIME is a measurable quantity, or may be considered under the ideas of equal, or of greater and less. Most men are capable of perceiving equal intervals of time, provided those intervals do not exceed a certain magnitude. When we hear a number of successive strokes, we can generally determine whether the intervals betwixt them are equal or unequal. We acquire this idea of equal intervals of time, from the motion of our own limbs, and of those of other animals, in walking or flying, which nature, for the purposes of ease and grace, has determined to be an uniform motion. We acquire the same idea from the movement of pendulums, and from the beating of clocks and watches. By a habitual attention to these, men come by degrees to have a very accurate perception of small equal intervals of time.

WHEN we have fixed our attention upon any such interval, and consider it as an unit of time, we can suppose it divided into a certain number of equal parts; and by motion we actually can make such a division. When we stand beside a clock, we can, with great ease, make a certain number of uniform or equal timed strokes in the intervals betwixt the several beats. This power of division, however, has its limits. Although we may conceive an interval to be divided into any number of

equal parts, the number of parts into which we actually can divide it must depend upon the powers which we have of performing quick motions. These powers are very limited. The roll of a drum, the most rapid movement of a musician upon an instrument, does not divide a second of time into much more than sixteen or eighteen equal parts, hardly ever into twenty-four. Our power of dividing a small interval of time, equally and uniformly, and of perceiving such a division by the ear, is also confined to certain proportions. The simplest and the easiest division is into two, or any of its powers which are within the limits of practicability. We can divide an interval into two or into four equal parts with almost the same ease. Having obtained either of these divisions, we can also consider each of the parts as an unit, and subdivide it into two or four, thus making a division into eight, or, if our powers of quick motion will admit, into sixteen *. Beyond this we cannot carry the powers of two in the division of single intervals. The division into three equal parts is not so simple as that into two. By practice, however, it comes to be equally easy. Having established this division, we can, as in the former case, subdivide each of them into twos, into threes or into fours, thus obtaining a division into six, nine and twelve. We also obtain the numbers six and twelve, by breaking down into threes each of the parts of a division by two or four †. A division into five equal parts requires a considerable effort of the attention. We sometimes meet with a succession of such divisions in the works of musicians. In executing such passages, the performer, fixing his attention upon the unit, probably runs on to the end of the succession

* EIGHT is most easily conceived as two fours; sixteen is always conceived as four fours.

† SIX we can indifferently conceive as three twos or as two threes; nine we must conceive as three threes; twelve we can either conceive as three fours or four threes; we can also conceive it as two sixes, but with more difficulty as six twos.

succession as uniformly as he can, without greatly regarding the numbers. When we attempt the division into five, we are often disposed to break down the interval into two parts *, and subdivide the one part into three, and the other into two, making the two either equal to each other, or in the proportion of one and two. In the same manner, when we attempt the division of an interval into seven, we are perhaps irresistibly led to halve it, giving three to the one half and four to the other. A division into any of the higher primes is impracticable.

WE have not only the power of dividing and subdividing small intervals or units of time in the manner I have explained, but we can also form aggregates of them, by telling off equal parcels of them, when they are rendered sensible to the ear by repeated strokes or sounds. We do this, by attending particularly to the first of each of the parcels. The consequence of this is, that though the successive strokes give out exactly the same sound, and are made with the same degree of force, we shall infallibly imagine the first of each of our parcels to be somewhat louder or more strongly expressed than the others. When we have counted off one parcel, the mind considers the whole as one act; the parcel is as it were set by, and a new effort is made to count off the next parcel. Hence the first of this parcel, being marked by a particular effort of the mind, and as it were representing the whole parcel, strikes it more strongly than the rest, and is therefore conceived as louder; and the last of the parcel, being least attended to by the mind, is conceived as feeble, thus giving us the impression of something like a break or pause betwixt the parcels. Thus, when we listen to the beats of a watch, we are at first disposed to reckon them by pairs; and we invariably find, that the first of each pair is considered by us as a strong, and the other as a feeble sound.

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* MORE especially if, in former parts of the succession, the same interval has been found frequently divided into two.

We may be easily satisfied, however, that this is not always owing to any real inequality in the force of the sounds ; because we can often reverse this order, by fixing the attention upon one of our feeble sounds, and considering it as the first of a parcel. After we have listened for some time to the beats, according to this new arrangement, we still find that the first of each pair is strong, and the other feeble. We can tell off the beats, not only by pairs, but also by parcels of three, four and other numbers ; and in every case we uniformly imagine the first of each parcel to be more forcible than the others. We form these aggregates with greatest ease, according to the same proportions in which we make the divisions formerly described. We count off the successive equal intervals, marked by repeated sounds, most easily, by parcels of two and of four. When the single intervals are not large, we can also make parcels of eight. These arrangements give what the musicians call common time. We can also, with sufficient ease, reckon them by parcels of three and of six, thus obtaining what is called triple time. We can do more : we can even form aggregates of five equal intervals. We seem to do this by first telling off two pairs, then accounting the fifth a feeble sound, fixing the attention upon the sixth, and making that the first of the next two pairs, and so proceeding. We might, in the same manner, form aggregates of seven. As, however, by counting off three successive pairs, the mind has in a manner established the arrangement of strong and feeble sounds, it becomes greatly more difficult to consider the seventh as a feeble sound, and to fall into the new arrangement. Even when we reckon by parcels of five, we are desirous of having some little time to establish our new arrangement ; and when the intervals marked by the successive sounds are perfectly equal, we always feel as if the sixth came upon us too soon ; we wish that it might be suspended till the time of the third pair is completed. Aggregates of five occur frequently in poetry. They have sometimes,

times, we are told, been attempted also in modern music, but never with success, and are now universally laid aside *.

BESIDES the powers which we have of dividing and subdividing small equal intervals or units of time, and of counting them off by equal successive parcels, we have still the farther power of combining together certain numbers of these parcels, or of feeling such combinations, and considering them as something separate and distinct from what went before and what is to come after. We make these combinations by twos, by threes and by fours, rarely I believe by any other numbers. The parcels by which we first count off the intervals, are, in modern music, called *bars*, being marked in writing by perpendicular lines drawn across the staff. Combinations of two, three or four of these bars are called musical phrases or strains. The first note of every bar is accented †. In parcels of four, the third, being the first of a pair is also accented, but not so strongly as the first.

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* THE ancients defined certain measures, which they considered as aggregates of five and of seven, as measures of which rhythmical successions might be formed. These they supposed to be made up of lesser measures, bearing to one another, in the one case, the sesquialter proportion, or that of two to three, and in the other case the epitrite proportion, or that of three to four. Whether they had, or could have, a distinct feeling of these numbers, upon hearing a succession of such measures expressed in syllables, or whether such a succession could be expressed so as to communicate such a feeling, are matters with regard to which I am much inclined to doubt. We may indeed conceive aggregates of five to be formed by counting off twos and threes, or threes and twos alternately; and, in like manner, aggregates of seven, by counting off threes and fours, or fours and threes. This, however, can hardly be done, unless the single times are of such magnitude, as that they may be considered as units of time, which is not the case with the short syllables of words. Even when the single times are sufficiently large, the counting them off by alternate even and odd numbers, is a difficult, perhaps an unnatural operation. It requires such a constant and even painful effort of the attention, as is inconsistent with that ease and simplicity of conception and operation, which is essential to every thing that is agreeable. If the attention is relaxed, we must either hold entirely by one number, or run into confusion.

† I HAVE here used the term *accent* in its musical acceptation, to denote that imaginary degree of force or emphasis which a sound acquires from the circumstance of its being the first of a parcel in a rhythmical succession.

THIS process of dividing and subdividing, of compounding and supercompounding small intervals or units of time, as I have now stated it, appears, at first view, to be extremely complicated. The whole, however, is undoubtedly gone through by every one who executes a piece of regular music in just time, and by every one who hears a piece of music, and perceives the measure of it; and this apparently without any labour or exertion of the mind. Perhaps the process, by which we perceive the relations in tone, which musical sounds bear to each other, is still more complicated, and yet this goes on even without our consciousness.

WHEN we hear a piece of music, we first mark the single intervals or units of time; afterwards, from the superior degree of force with which the accented notes are expressed, or from some circumstances in the sound or the rhythm which draw the attention to these notes, we very quickly discover, how many intervals are contained in each of the equal parcels, according to which the measure is constructed. Having established this, we can with great ease go along with the performer, and feel the proportional duration of every note. We are provided with a standard or scale, to which we can refer the most minute divisions that can be made, and by which we can measure the longest notes that may occur. If we are unacquainted with the piece, and do not at first perceive the measure, we are kept, during all that time, in a disagreeable state of suspense, and are unable to listen with any degree of pleasure or satisfaction.

THE measure is most easily perceived when the bars naturally combine into twos or fours, and when of these combinations the whole or each part of the piece contains a determinate even number. In this manner, the simple popular airs, such as marches, gavots and minuets, are constructed. There are very few who cannot easily perceive and relish the measure in such airs. This regular structure, however, is not observed
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in all music. In some pieces, the bars do not regularly combine into phrases, or, if they do, the phrases do not always contain the same number of bars. The number of the bars, too, is indeterminate, and sometimes very great. In such pieces, then, the measure must in general be formed of single bars or parcels; and if the rhythm is variegated by a considerable range of long and short notes, and if the accented notes do not forcibly engage the attention, an unpractised hearer will sometimes hardly perceive the measure at all. When this happens to be the case, it is impossible that he can receive any great pleasure from that music. According to the language used upon such occasions, he does not understand it. Such difficult and perplexed measures, however, occur more rarely in the later compositions than in those of the last century.

IN such measures, beating of time is of great use both to the performer and to the hearer. This seems to have been a practice ever since man had an idea of rhythmical measures. We are naturally disposed, upon hearing such measures distinctly expressed, to accompany them with corresponding motions of the body; and hence probably the origin of dancing, to which exercise the term rhythm has been frequently applied. The beating of time is performed by putting down the hand or foot, and giving a stroke at the instant in which the first note of every bar begins to be sounded, and raising them up during the remaining time of the bar. This both directs the performer to execute the piece in uniform time, and enables the hearer readily to perceive the accented notes, and to ascertain the measure. The ancients, in the performance of their music, and especially of their dramatical music, where the band was numerous, beat time with great force and noise. This was perhaps necessary, as their measures were frequently unequal and irregular. The moderns, who generally construct their music by equal and regular measures, have laid aside that practice in every case where it is not indispensable. We un-

doubtedly listen with more satisfaction when we can perceive the measure from the real accent and expression of the notes, than when we must be assisted by the continual repetition of unmusical sounds.

SUCH then seem to be the nature, the extent and the manner of operation of what may be called our rythmical powers, or those powers by which we ascertain and perceive the proportional magnitudes of small intervals of time, when these are marked out by motion, or by successive sounds. And from what has been said, we easily see what a prodigious variety may be introduced into musical rhythm, from the great range of long and short sounds which may be occasionally employed, and which may be disposed and combined in a number of different ways almost infinite, without perplexing the hearer, or hindering him from readily and accurately feeling the proportional duration of each.

IN the foregoing account of these powers, I have frequently spoken of single intervals or units of time. It may be proper, in this place, to explain a little more fully what I understood by these terms. It will readily occur to every one, that I did not mean to express by them a certain invariable portion of absolute duration. These units, like units in all other subjects, are indeterminate and relative magnitudes. They mark sometimes a greater, and at other times a less portion of absolute duration. The same portion of absolute time will, upon different occasions, be considered as an unit, as a multiple and as a part. Every one, however, who has been conversant in music, experiences, that when he performs, or when he hears and goes along with a piece of music, there are certain notes which he uniformly considers as single durations, of which all the longer notes that occur are aggregates, and the shorter notes are parts. He may therefore be very properly said to have all this while the idea of an unity of time. Although these units of time differ considerably in their absolute duration in different movements,

ments, this difference is undoubtedly confined within certain limits. They can scarcely be much greater nor much less than the intervals marked by those natural uniform motions from which our original impressions of rythmical movement are derived, and particularly the motion of our own limbs in walking or running. Perhaps the longest sound which can be considered as a single undivided duration, is hardly equal to the time of two seconds; and the shortest which can be easily counted without parcelling, is not much less than half a second, or than the time in which we can distinctly pronounce the numeral names in succession. We can indeed attend to the single beats of a watch, but not without a considerable exertion of the mind; we reckon them much more easily by pairs or by fours.

It might here be asked, what occasion is there, in order to explain our perception of rythmical proportion, for supposing it necessary that the two opposite operations of division and combination go on at the same time? Would it not be more simple and more natural to suppose, that the whole process is carried on in the same direction, and by the same operation; and that either the longest sound which occurs in the succession is to be accounted the unit or standard, and all the shorter ones formed and conceived as proportional divisions of it; or else, that the shortest sound is to be taken for the unit, and all the longer sounds conceived as formed by combination? The answer is, that the process of dividing and combining appears to be the process of nature; and, for proof of this, appeal might be made to experience. When a person is instructed in music, he is taught to mark the time of a semibreve by four uniform motions of the hand. He is thus accustomed to consider it, not as one time, but as four times, expressed, not separately and distinctly, but in continuance; and I may venture to say, that the most experienced musician does not conceive such lengthened sounds in a different manner. By practice and discipline,

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cipline, indeed, he is enabled to give them a smooth and uniform intonation, without marking the single times as they pass, by a swell or more forcible expression; but still he is all the while reckoning those single times in his mind, or attending to the accompaniment by which they are for the most part distinctly articulated. These lengthened sounds, therefore, never are conceived as units or single durations, but always as compounds. On the other hand, many sounds occur in music which are too minute to be counted individually. These, therefore, can only be conceived in groups, by being referred to some longer duration of which they are aliquot parts. This may be farther proved from the following circumstance: In musical successions, we often find a duration which may be considered as an unit, divided at one time into fours, and at another time into threes or triplets. These minute times, therefore, will be to one another in the proportion of three to four. If, therefore, it is thought practicable to account such small time the unit or standard of a rythmical succession, to which all the other times are to be referred, and by which they are to be estimated, I would ask, which of the two minute times is to be taken for the unit, in the case above described? If the smallest is pitched upon, I would farther ask, by what means are we enabled to express the other accurately, in proportion to it as four to three, or to feel this proportion as subsisting betwixt them, especially as both are supposed to be incapable of further division? The matter seems to be impossible. Such passages, however, are, by no means, considered as difficult or embarrassing, even by young performers. These small times, therefore, are not conceived as units, but as divisions, by the simple numbers four and three, of some longer duration, which has been often distinctly marked in the former parts of the piece, and with which the mind is familiar.

THESE

THESE opposite operations of division and combination facilitate and simplify the process of rhythmical perception, and, at the same time, enable us to take in a much wider range of proportion, than could be done if we proceeded only in one direction. As the unit is commonly some intermediate time betwixt the longest and the shortest which occurs in the succession, it bears no very distant proportion to either of them. We frequently meet with semibreves and semiquavers in the same piece of music; notes which are to one another in the proportion of one to sixteen. This proportion is too great to be conceived and felt by a single operation of the mind. When, however, the crotchet is accounted the unit, we are enabled to estimate, and accurately to express, these distant times, without going beyond the simple and familiar proportion of four to one, on either hand.

THE ancients indeed accounted their smallest time as the unit or standard of rhythmical movement. This smallest time, however, was not less than that of a short syllable in pronunciation, and they had no sounds in their successions, which they considered as bearing to this a greater proportion than that of two to one. It may also be of importance to remark, that as their arithmetic was very imperfect, compared with that of the moderns, it is very probable that they had not the same ideas of fractional division, which we now have. In treating upon any subject, therefore, in which number is concerned, they would naturally take for their unit the smallest of the kind which they were examining, something that was either naturally indivisible, or that they did not expect to be under the necessity of dividing. Thus ARISTIDES QUINTILIANUS calls the single time of rhythmical movement *σημείον*; a term by which, as he tells us, geometricians expressed that which has no parts. This time, he adds, being without parts, holds, in some degree, the place of unity*. The moderns, on the other hand, being able

* Page 32, 33. Edit. Meib.

able to conceive and express proportional divisions of the unit, with as much ease and accuracy as they do aggregate numbers, have it in their power to take their unit of such dimension as best suits the nature of the subject. This circumstance may perhaps enable us to account for some of those differences which take place betwixt the opinions of the ancients and of the moderns, upon the subject of rythm.

THERE are a few remarks which it may be necessary to make, before I conclude this part of the subject.

IN music, we sometimes find the unit of time divided into two unequal parts, in the proportion either of two to one, or of three to one. In making or perceiving this division, we do not first break down the unit into three or four, and then allow two or three of these to the first note, and the remaining one to the other. We have not leisure for this operation. We merely conceive the one as prolonged and accented, and the other as abrupt and feeble. Hence, when we hear such divisions, it is very difficult, without the assistance of the other parts of the measure, to determine whether they are made according to the one proportion or the other. A practised ear will frequently mistake, and in writing music the one is sometimes substituted for the other.

AFTER a distinct impression has been obtained of the units of which a rythmical succession is composed, and of the parcels according to which it is constructed, we do not lose that impression, although the succession should stop, or no sound be heard, during the time of one or more of the units. These vacant or silent times, if they are not too long continued, we reckon with nearly the same ease and certainty, as if they had all been expressed by sounds; and we clearly perceive the particular part of the measure at which the succession of sounds recommences. These silent times are called *rests* in music, and are always accounted as part of the measure. But this is not all. We can in a manner stop the course of the rythmical movement,

movement, or suspend the flow of the units, during a time which is either indeterminate, or of which we take no exact account, and proceed afterwards as if no such pause had been made. These *ad libitum* pauses, as they are called in music, are seldom taken into the measure, or considered as making any part of it. The intention of them is to rouse and strike the mind of the hearer; and there are various occasions on which they may be introduced with very happy effect. Modern musicians often use them as opportunities of displaying the extent of their invention and execution, when losing sight of the composer, giving the reins to their fancy, and little regarding rule or measure, they entertain their hearers with a series of rapid divisions through the whole compass of their instrument, and of uncommon and irregular modulations. But farther, we can not only suspend for a time the course of the rythmical movement in the manner above described, we can also render it occasionally slower or quicker, by increasing or lessening the dimension of the unit, when we wish to express a heavy languid movement, or one that is light and animated; and after having executed a part of the succession in that manner, we can often, with great accuracy, resume our first unit, or return to our original time. We probably do this with most certainty, when this enlargement or diminution of the unit is made in some sensible proportion, as that of two to one. This practice, and the effects of it, were well known to the ancients. They made it a branch of their rythmical institution, under the title of *Αγωγή ῥυθμική*, or *Ductus Rythmicus*.

In music, the accented note, or beginning of the measure, is not always the first note that is founded; it is often preceded by one or more feeble notes, which are placed before the bar or perpendicular line which marks the commencement of the first measure. These introductory notes are thought to give a softness and delicacy to the opening of the piece. In regular music, when the parts are repeated, the time of these notes

is always compensated at the conclusion of the strain. The most graceful close of a rythmical succession is when the last sound is long. We also rest upon this sound with most satisfaction when it begins upon an accented part of the measure. In this case, that measure may be left incomplete, by the exact quantity of the introductory note; so that when the strain is repeated, this incomplete bar at the end, together with the introductory note at the beginning, make up one entire measure.

I NOW come to make some observations upon the rythm of poetry.

IT has already been remarked, that words being composed of syllables which differ in length according to certain proportions, are susceptible of rythm. In all compositions, therefore, the object of which is to please and to affect, it has been the general practice to arrange the words in some agreeable rythm. One very common method for attaining this end has been, to form the words into parcels, according to certain measures and proportions; and in order that these parcels may be more readily perceived and attended to by the reader, to write them out in separate lines.

THIS poetical rythm cannot possibly be so various and complicated as the musical. The same principles, however, to a certain extent, take place in both. We find in poetry small intervals or units of time regularly divided and combined. The divisions, indeed, cannot possibly be so minute as they often are in music; neither are the parcels so equal and uniform. We have also in poetry accented and feeble sounds; and verses, like musical strains, are often introduced by one or more feeble sounds, which sometimes are compensated at the end of the verse, and at other times are not. In poetry, as in music, we often make up a part of the measure by rests or silent times. In reciting verses, too, we can make indefinite pauses; and

and we are often insensibly led by the sentiments or by the structure of the words, to execute the *ductus rhythmicus*, or occasionally to accelerate or retard the movement.

In the ancient Greek and Latin languages, the proportion betwixt the long and the short syllables is better ascertained, more distinctly marked, and more sensibly felt, than it is in the modern languages of Europe. Those languages are, therefore, susceptible of a more perfect and a more diversified rhythm. The poets who have written in them have availed themselves of this advantage, and have left us in their works a variety of very pleasing rhythmical measures. Critics have discovered the rules by which these measures were constructed; and, in order to explain them with greater ease, have established and defined different small scales of long and short syllables, which have been called metrical feet, and by which the different measures have been parcelled out into their component parts. The names and the nature of these feet are generally known, and need not, in this place, be explained. I shall only, at this time, make two observations upon them. The first is, that they seem, in general, to mark what I have formerly called single intervals or units of time, and these not very large. Any one may find, when he recites a verse, that he can easily pronounce two feet in a second; but that he can hardly draw them out, so as that each of them shall occupy the time of a second. The other observation is, that it does not appear to have been the intention of the persons who defined and applied these feet, to divide verses by them always into equal intervals of time. The formation of them proceeds upon the supposition, that when a person recites a poem, he pronounces every short syllable in one determined space of time, and every long syllable in a space of time exactly double of that in which he pronounces a short one. The real duration, therefore, of any one foot will be to the real duration of any other foot exactly in proportion to the number of these smallest times contained

in each ; and this can be accurately determined, by observing the number of long and short syllables in each of them, and accounting every long syllable equivalent to two short ones. In this manner we find, that the duration of an iambus or trochæus is to the duration of a spondæus or a dactylus exactly in the proportion of three to four. When these feet of unequal time, therefore, occur in the same verse, which frequently happens in scanning, it is evident, that, upon this supposition, they do not divide that verse according to equal intervals of time. Whether the supposition of this proportion, invariably subsisting betwixt long and short syllables, upon which this system depends, be in every case well founded, may be the subject of future enquiry.

THE units of time, of which the duration of verses is made up, are sometimes divided into twos and fours, and sometimes into threes. Of the first we have an instance in the common hexameter verse of the ancients. This is a regular rhythm, the units being all equal, and formed into equal parcels. The number, of which the parcels consist, is six. It may therefore be considered as a triple measure. In verses, as well as in other rhythmical successions, the parcels of which consist of any number greater than three, we are always disposed to break down these parcels into the smaller numbers of which they are composed, or to consider the whole parcel as an aggregate of these smaller parcels. This is the origin of what is called the pause or cæsural stop in verses. As, according to what was formerly stated, the close of a rhythmical succession, whether final or partial, is most agreeable, when the last sound is long and accented, and as we are often disposed to begin a succession with one or more feeble sounds ; so, in making the divisions of verses, we rest with most satisfaction upon a long syllable in an accented part of the measure, and begin the succeeding member most easily with a short or feeble syllable, which we, in a manner, pass over, and consider as introductory to the
measure.

measure. The most simple division of six is into two threes. Hence we generally wish to conclude the first member of a hexameter verse with the first syllable of the third foot; and are pleased, when we have an opportunity of doing so, by that syllable being the termination of a word.

Tityre, tu patulæ — recubans sub tegmine fagi.
Nos patriæ fines — nos dulcia linquimus arva.

This division of the hexameter verse, not only gratifies the natural propensities above mentioned, but, as the concluding syllable of the verse is in the unaccented part of the measure, it gives a variety to the cadence of the two members, and prevents them from being similar or convertible*, which is always considered as a fault in the structure of verses, and undoubtedly gives them a disgusting uniformity. We can also make the break at the second syllable of the third foot, when it happens to be a dactyle; as, in this case, we have still a feeble sound with which to begin the second member, and the time of the first member is more nearly completed.

Formosam resonare — doces Amaryllida filvas.

This penthemimer division of the hexameter verse, though the most agreeable, does not always take place. To obtain variety, it is necessary that it should occasionally be divided otherwise. The number six may also be easily conceived as made up of three pairs. By making the break at the first syllable of the fourth foot, we have two pairs, deficient of their just time by the feeble syllable or syllables, which are introductory to the measure of the succeeding member.

Ille meas errare boves — ut cernis, et ipsum.

K 2

The

* As, Cornua veletarum — vertimus antennarum.

The grammarians, led by the system of half-feet, would not probably consider the division which I have made of the fifth line of VIRGIL's first Eclogue, quoted above, as the just one. They would rather suppose that the break took place at the end of the word *doces*. They would also suppose a subordinate division at the word *formosam*.

THE division of the units into twos and fours, which takes place in the hexameter verse, seems best suited to the structure of the Latin and Greek languages. Pure trochaic or iambic verses, where every alternate syllable is prosodically long, and the others are short, occur but rarely in their works. Our language, again, seems scarcely to admit of such divisions. In our poetry, the syllables are arranged less according to their real quantity, than according to the accent* with which we are accustomed to pronounce them. An accented syllable has always the effect of a long one, and is qualified for being placed in the leading or accented part of a poetical measure. An unaccented syllable, on the other hand, gives us the impression of a short one, though by the common rules of prosody it ought to be long, and though it is, in reality, pronounced long. It is also disqualified for being placed in the accented part of a measure. We have few instances of a real dactylus in single words, though three short syllables, from the accent with which the first is pronounced, often assumes the appearance of one. English verses are constructed for the most part by feet of two syllables. The proportion which these two syllables bear to one another is seldom perceived with accuracy; neither is it of great importance that it should be so perceived, provided the times of the entire feet, or of the two syllables taken together, be nearly equal. The impression, however, which these feet,
for

* WHEN I apply the term *accent* to syllables, I use it in its grammatical acceptance, to denote that superior force of articulation, and that inflection of the voice, with which we always mark in our pronunciation some particular syllable or syllables of every word.

for the most part, communicate, is that of a trochæus or iambus. Our poets also construct verses sometimes by feet of three syllables. These feet, although the syllables of which they are composed are, for the most part, nearly equal, give us the impression of something like a dactylus or anapæstus, according as the accented syllable is the first or the last of the three. In regard to their structure, therefore, English verses have been distinguished into three kinds, trochaic, iambic and anapæstic*.

ALTHOUGH all iambic verses are to be considered as trochaics having a feeble syllable introductory to the measure, and ought always to be so scanned, yet the impression which these two verses make upon the ear, and the effects which they have upon the mind, are somewhat different. When we begin with the feeble sound, we pass easily and gently from it to the strong sound. We utter the strong sound without much exertion, and can dwell upon it for some time. On the contrary, when the strong sound comes first, we express it with more difficulty and force, and pass on to the succeeding feeble sound with more rapidity. Hence trochaics have been generally reckoned somewhat quicker in their movement than iambics, and more proper for expressing vehemence or gaiety. As iambic verses themselves, however, have naturally a light and airy cast, especially when the combinations are made by even numbers, our best poets, to obviate this, have, in their more serious compositions, generally adopted a combination of five. This has accordingly been denominated the English heroic measure. The regular model of this verse is as follows. The first syllable is unaccented, or short and introductory to the measure. This is succeeded by four feet of two syllables, which, as the accent

takes

* ENGLISH trochaic and iambic verses may be set to music in common or in triple time indifferently. Anapæstic verses require, for the most part, to be set in triple time. SHENSTON'S Pastoral Ballad set in common time, would lose much of its beauty and delicacy.

takes place upon the first syllable, may be considered as trochees. After these, there is a strong or accented syllable, which closes the verse, and, along with the introductory syllable of the next line, completes the number of five feet*.

To | wake the | soul — by | tender | strokes of | art.

This model is not always observed. Our best poets make frequent deviations from it, in order to give variety to the cadence of their verses, or to render them more expressive of the sentiments or emotions which they wish to convey.

THIS verse, like the ancient hexameter, admits of a break or division. As, according to what was formerly observed, we generally reckon combinations of five by two pairs and an odd one, we make this break with most satisfaction upon the leading sound of the second foot, or the fourth syllable of the verse.

To make mankind — in conscious virtue bold.

We can also make a division at the sixth syllable, as in this case we have still one pair, with its introductory sound, remaining.

Of that forbidden tree — whose mortal taste †.

Sometimes too the words are so arranged, that the division must necessarily take place at the fifth syllable or feeble sound of the second foot. This division gives a pause more real, and more distinctly felt, than those formerly mentioned. As we must begin

* THIS verse is a combination of five times, more in appearance than in reality. When it is well constructed, it will seldom fail to give the person who pronounces it the disposition and opportunity, by means of rests, of completing six, sometimes perhaps eight times.

† WHEN, by means of rests at the close, the time of six feet is completed in pronunciation, this break divides the whole time into two threes.

gin the second member with a strong sound, and are partly deprived of the assistance in forming it, which we would have derived from the preceding feeble sound, we require a little more time to make the exertion which is necessary for that purpose. This division also changes, in some degree, the character of the verse, the last member becoming proper trochaic. It may sometimes, however, be used with a very happy effect. There seems to be an instance of this in the first line of POPE'S Essay on Man.

A|wake, my | St JOHN. | — Leave all | meaner | things,

Here the grammatical pause, coinciding with the rythmical division, gives sufficient time to form the accented sound with which the second member begins; and that member being trochaic, is very well suited to express the intention of the poet, which is to rouse. The same division occurs in the second line; but the effect of it is somewhat different.

To low ambition — and the pride of kings.

In reciting this line, we are unwilling to give an accent to the conjunctive particle *and*. To avoid this, therefore, we are disposed to consider both that word, and the article which follows it, as feeble sounds, introductory to the next strong sound, and to fill up the time of the accented part of that third measure by a silence or rest.

To | low am|bition — | and the | pride of | kings.

In this way, the reciter, hurrying over these two comparatively unimportant words, almost in the time of one feeble syllable, is naturally led to express the word *pride* with considerable force or emphasis; a circumstance which seems, in this place, to fa-

vour

vour the design of the poet. Verses of this form occur frequently in the works of this author.

THE structure of the English heroic verse, and the uneven number of feet of which it is composed, effectually secures it against the danger, or even the possibility of its being divided into two parts which are equal, and at the same time similar and convertible. When the break takes place at an accented or strong syllable, the two members are necessarily unequal. When, again, as in the two lines last quoted, the division happens at the fifth syllable, the two members, though they may be equal in time, are necessarily different in cadence, as the first begins and ends with a feeble sound, and the second regularly begins and ends with a strong sound. This seems to give to the English verse of this form a considerable advantage over the common French verse of six feet, which uniformly divides into equal and similar hemisticks.

THESE breaks or divisions in verses have perhaps been improperly termed pauses. In many cases, the pause is more imaginary than real. I have formerly observed, that we have always, in a greater or less degree, the impression of a pause betwixt every parcel of equal times which we form. When we hear a minuet, or any piece of music, which is constructed according to regular rhythm, we have the impression of a pause at the end of every bar; we have the same impression more strongly at the end of every phrase; and yet we are certain, that, at many of those passages, no real pause is made. It frequently happens, that the proper break or rhythmical division of a verse takes place at one part of it, when the rest, the grammatical stop, or the pause of suspension, occurs at another part of it.

And | leaves the | world — to | darkness | { and to | me.

In this line, the rhythmical division takes place at the fourth syllable, where little or no real pause is necessary. From what

was

was above observed, however, upon the structure of the second line of POPE's Essay on Man, there must be a sensible rest or silence betwixt the seventh and eighth syllables. Accordingly, this has commonly been considered, and perhaps with propriety, as the place of the pause in this line. It is probable, however, that the cadence of the verse would not have been so agreeable and satisfactory, if the regular rythmical division had not occurred at the fourth syllable.

SOME additional observations upon rythmical measures, and upon the structure of ancient and modern verses, shall be reserved to the second part of this Essay.

P A R T II.

IN the former part of this Essay, I endeavoured to establish the general foundations of rhythm, and to explain the nature and the extent of those powers, by which we perceive the proportional magnitudes of small intervals of time, when these are made obvious to the senses by motion or by successive sounds. The case of sounds being that which is most interesting, I directed my attention chiefly to it. Rhythm in sound I distinguished into three kinds, musical, poetical and prosaic; and made some observations upon the two first of these. I propose, in this part, to offer a few observations relative to the same subjects, which may tend to throw some further light upon them. In these observations, I shall have the following objects chiefly in view: To explain that structure or arrangement of measured sounds, which may be said to give a regular and perfect rhythm; to mark the gradual deviations from that regular structure, which appear in those productions of human genius which are

intended to please, and of which the agreeable effect depends, in any degree, upon rhythm; and, lastly, to apply the principles which may be delivered, to illustrate some particulars in the structure of verses.

IN entering upon the first of these, it will be proper to recapitulate shortly the account which I formerly gave of what may be called our rhythmical powers.

FROM our constitution, or from our habits, we have the power of marking and perceiving equal intervals of time, when those intervals do not exceed a certain magnitude. When we fix our attention upon one of those intervals, and consider it as an unit of time, we can suppose it to be divided into a certain number of equal parts, and by motion we actually can make such a division. The number of parts into which we can thus divide a given interval, must necessarily depend upon the powers which we have of performing quick motions. It is, however, regulated also by the preference which the mind naturally gives to the simpler numbers. We divide with greatest ease by two and its powers. We can also, with sufficient ease, divide by three, nine, and the smaller compounds of two and three. To make an equable division into five is difficult, into seven is perhaps impracticable, and into any of the higher primes is certainly so. Again, when we hear a number of equal intervals of time distinctly marked by successive sounds, we are always disposed to count them off by equal numbers, thus forming them into sets or parcels. In doing this, as in making divisions, we always prefer the simplest numbers. When, therefore, there is nothing in the nature of the sounds to determine our choice, we usually count off the intervals by pairs, by fours or by eights. We can also, with sufficient ease, count them off by threes and by sixes. As the first sound of each parcel is marked by a particular effort of the mind, and considered by it as representing the whole parcel, it is conceived to be more forcible than the other sounds of that parcel, which, being less
attended

attended to by the mind, are conceived as feeble. As five is too large a number to be comprehended by one individual act of the mind, we can only form parcels of that number, by counting off two pairs, considering the fifth single sound as feeble, and fixing our attention upon the sixth, as the leading sound of the next pair; or by counting off twos and threes, or threes and twos alternately. This insertion of the single time, at the end of every two pairs, changes the order of the strong and feeble sounds, in every succeeding parcel. Although this operation is practicable, it is probably very seldom actually performed. The frequent and sudden changes of the arrangement of strong and feeble sounds, require an uneasy effort of attention in the performer, and give an unpleasant surprise and disappointment to the hearer. Both feel a strong desire to have the number of six times completed, either by a lengthened sound, or by a silence. Lastly, we have the farther power and disposition to join together two, three or four of our first parcels, thus forming larger combinations.

By means then of the powers now described, we are enabled to express a succession of sounds whose durations may be very different, but may, at the same time, be most accurately related to one another, according to certain proportions. We are also enabled, upon hearing such a succession of sounds, with readiness and ease, to feel the proportional duration of each, provided the simple proportions above mentioned be constantly observed. In order to this, we first of all fix our attention upon some determined duration, which may be something near to the intervals observed in walking, or in some other of the uniform motions with which we are familiar. This duration we consider as an unit of time. Having established this, we can express any number of them with great uniformity; we can divide some of them as we go along into parts, or combine two or more of them into lengthened sounds. By habit, we can take our unit, at different times, greater or smaller; we can

make larger combinations, and more minute and diversified divisions. We go through a similar process, when we listen to such a succession of sounds, and perceive their proportional durations. As the exercise of every power, which we possess, conveys a certain degree of pleasure, we obtain a gratification, when we hear a succession of sounds justly proportioned in duration to one another, and are able, at the same time, to go along with, or to feel the several proportions which they bear. This then is undoubtedly one foundation of the satisfaction which we derive from every kind of rhythm. It can be no just objection to this, that we frequently are not conscious, upon hearing a succession of rhythmical sounds, of perceiving the various proportions which they bear to one another. Our being pleased with the proportions, our acquiescing in them, is a sure indication that we feel them. If the unit were varied, or if divisions were attempted, to which we have not been accustomed, and with which we cannot go along, we should instantly feel the difference. Our pleasure would be sensibly diminished or altogether destroyed.

To form then a regular and agreeable rhythm, it is necessary that all the units in succession be equal intervals of time, and that their divisions be simple and obvious. This, however, is not all. I have already observed, that when we hear such a succession of intervals, we are always disposed to form them into equal parcels. As, however, there seems to be nothing to lead us to count off these parcels by any one number in preference to another, and as we can do it by a few of the smaller and simpler numbers with almost equal ease, we naturally wish to have something that may determine our choice. If we are not led easily and readily to one particular number, or if, after we have fixed upon a number, we find ourselves obliged to give it up, and to adopt another number, we are uneasy and dissatisfied. For this reason, a rhythm that may be perfectly agreeable and satisfactory, must be constructed according to some measure;

sure ; the whole succession must be made up of parcels of some determined number of units, and must be so contrived as that the hearer may be instantly led to adopt that number, and retain it to the end of the succession. This may be effected by various means. If, for instance, we wish that the hearer should count off the equal times by parcels of four, we may first express four distinct and undivided units, and afterwards other four in some way combined or divided *. By this means, the hearer will naturally be led, after having reckoned four units, to stop and begin a new parcel. He will be still more confirmed in this arrangement, if we make our third parcel similar to the first, and our fourth similar to the second †. We may obtain the same end, by expressing three distinct undivided units, and resting during the time of the fourth, and still more certainly by doing the same thing over again. In like manner parcels of other numbers may be suggested. Various other contrivances for indicating the measure, will readily occur to every one who attends to the works of musicians. The return of similar sounds, and of similar combinations and divisions, after any number of units has been expressed, naturally fixes the attention of the hearer to that number, and determines him to adopt it, for counting off succeeding parcels ; and if care be taken not to confound him, by bringing in such returns at different parts of the parcel, by continuing sounds from the end of one parcel to the beginning of the next, or by making minute and perplexed divisions, he will hold by that number to the end of the piece.

WE naturally wish, when hearing a succession of measured sounds, not only to form them into parcels, but also to join two, three or four of those parcels together, thus forming larger

* First movement of the sixth periodical overture, published by R. BRENNER.

† Symphony to the first recitative in HANDEL'S MESSIAH.

larger combinations or strains. We may be assisted in doing this, and determined to a particular number, by the same means by which we are assisted and determined in forming the single parcels, chiefly by pauses, and by the return of similar sounds, or of similar combinations and divisions. By being led to form such aggregates, the pleasure we derive from listening to the succession is greatly increased. We are thus provided with certain stages or resting-places, and are enabled to count off the parcels with more steadiness, and with a smaller effort of the attention. Our satisfaction is still farther enhanced, when the entire piece consists of some simple and agreeable number of such aggregates. We have then the impression of a whole, of something finished and complete; and have a lively perception of that proportion and arrangement of parts, which is essential to every thing that can be accounted beautiful or pleasing.

WE may now be able to form some precise idea of what may be called a regular and perfect rhythm. It is a succession of measured sounds, all of which are either equal to, or are certain multiples or certain parts of some determined portion of time, which may be called an unit, and are so arranged and disposed that the hearer is easily led to count off those units by equal parcels of some simple number, and also to combine two, three or four of those parcels together, the whole succession containing a small determined number of those larger aggregates. It is in this manner, that all those pieces of music, which are commonly called *airs*, are constructed. The regular minuet consists of two parts or complete strains, the units are constantly formed into parcels of three, and each part contains eight of those parcels or bars, which the hearer is disposed to combine into aggregates of two or four. The regular march and gavot are constructed in the same manner, only the bars or first parcels consist of four units in place of three.

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HAVING established this structure as the standard of regular and perfect rythm, I proceed to mark the gradual deviations from it that appear in those productions of human genius which are intended to please, and of which the agreeable effect depends in any degree upon rythm. The artists who have been employed in such productions, seem to have had two objects chiefly in view in occasionally departing from this regular structure, namely, to introduce variety into their works, and to render them more expressive of certain feelings and emotions of the mind. I can only at this time consider the first of these.

IN all those works which are addressed to the fancy, that which is most simple and most easily conceived, is always that which first of all engages the attention and communicates pleasure. While our powers of perception are yet in their infancy, it is impossible that we can go along with what is various and complicated. Nothing but what is distinctly felt can communicate real pleasure. We may perhaps not always be able to analyze our feeling, and may therefore say that we are pleased we know not why. When it is analyzed, however, it will be generally found to have been a distinct feeling, or in other words, the objects which excited it will be found to have been commensurate to our powers of perception. As we seem to derive our first ideas of small equal intervals of time, from the uniform motion of our own limbs, or of those of other animals in walking, we probably from the same source acquire the habit of counting off such intervals by pairs. When, from any circumstance, the first of each alternate pair is made particularly to attract the attention, we are then disposed to join two pairs together, to form parcels of four, or to consider each four as something separate and distinct from what went before and what is to come after. We may, in the same manner, be led to join two or four of these parcels together, in order to obtain what we may account a whole. Gradually we are enabled to
conceive.

conceive a single interval to be halved, and each half to be again subdivided in the same proportion. We thus obtain the spondæus, dactylus and double pyrrichius. It would appear, then, that something of the nature of the march or gavot measure above described, gives the most simple and easy rythm, and is that which would probably first of all strike and please the human mind. Dr BURNEY, in his account of CROTCH, the musical child, published in the *Philosophical Transactions*, remarks of him, that, when he plays from his own fancy, what rythm he observes is generally of the march kind, proceeding chiefly by the dactylus and spondæus. The first verses of the ancients were probably formed of the same measures.

As mens powers of perception improve, they naturally wish for objects suited to them. That which is most simple, and was at first most agreeable, gradually loses its charm; they wish for something that may give more employment to their powers. They could not, therefore, be always confined to the uniform movement by pairs and double pairs, but would endeavour in some way to diversify it. Their first contrivance for this purpose might possibly be, to depart occasionally from the original arrangement of two, four, eight, by throwing in an additional pair to their two, or two additional pairs to their four, thus making combinations of three or of six pairs. The dactylus and spondæus at the end of the common hexameter verse, may thus possibly have been an addition to the verses of four feet, which had formerly been used, and might then have been considered as an improvement. After combinations of three pairs had become familiar, it was an easy step from that to arrange by parcels of three units; and thus the simple triple time was obtained. This, though still farther removed from the original measure, became probably on that account the more pleasing. It gave more exercise to the rythmical powers; at the same time, it did not fatigue them. It was free from the solemnity and uniformity of regular pairs. The minuet accordingly ever
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has been, and is at this day accounted the most elegant and pleasing movement in music. This measure is almost entirely confined to music. There is scarcely an instance of verses, which are constructed exactly according to it, unless perhaps the Ionian verse of the ancients, a verse which does not often occur in their works, and which, from the heavy uniformity of its movement, is by no means pleasing *. From parcelling by threes, it was an easy transition to divide the unit by the same number. For this, nothing more was required, than gradually to diminish the unit, and to take the parcels of three by pairs: each parcel would come at last to be considered as a single unit divided. They would thus form the tribrachys, trochæus and iambus, according as they expressed each of the three parts separately, or joined any two of them together. In this way would be obtained the gig measure in music, and the trochaic and iambic verses in poetry †. Such parcels and divisions by three would probably at first be formed into strains or larger combinations, by twos and fours; and this is still the most usual arrangement. In process of time, however, they would also be formed by threes and sixes. Thus the trimeter or senarian iambic verse might be derived from the dimeter, or verse of four single feet.

So long as the bars or first parcels, whether of pairs or threes, are equal, the larger combinations uniformly contain the same number of bars, and these last are restricted to some simple and obvious number, the rhythm may be considered as regular. The most gentle deviation from this structure, if in truth it can be called such, is extending the entire piece beyond

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* THERE is only one ode of HORACE in this measure, viz. Book III. Ode 12. The rhythm seems to go on to the end, without any sensible break or close.

† THE tribrachys, or gig measure, may possibly have been suggested immediately from the sound of a horse's feet, when running at full speed.

the limits above assigned. The modern musicians frequently compose pieces of considerable length, and consisting of a number of bars too great for the mind to keep an exact register or account of them. This enables them to take a wider range of melody and modulation, than they could do if their pieces were confined within the limits of short regular air, and to prolong and diversify the pleasure of the hearer. If in such extended pieces, however, the bars uniformly assemble into equal groups or combinations, and if the whole piece, and each larger division of it, contain an even number of such combinations, the hearer has still the impression of a justly proportioned whole; and even within this limitation a very copious variety may be obtained. Men, however, could not always bear this confinement. In proportion as rythmical measures become more an object of attention, and are more frequently presented to the ear, the necessity of variety becomes the greater. The most agreeable measures, when too often repeated, become disgusting. We are often pleased with a bold deviation from what is strictly regular. The very surprise which it causes is agreeable. It seems to have been in part from this principle, that the composers of music have occasionally departed from the regular structure of rhythm.

THE least offensive deviation, which can be made from that structure, is the departing at times from the uniform equality of the strains or larger combinations. It is essential to the minuet that the bars constantly proceed by pairs. In the regular minuet, there is always a more distinct cadence at the end of every second pair. By this means, the hearer is led to join two pairs together, or to make combinations of four bars. This arrangement is necessary to render the rhythm of the music strictly conformable to the movement of the dance, which it is intended to regulate. The whole piece commonly contains four of those larger combinations, two of which go to the first part or complete strain, and two to the second. In order, however, to give
more

more variety and extent to the composition, a part may be made to consist of three, four or six of those combinations ; or, by occasionally adding two bars, combinations of six may be formed. All this may be done, without losing the distinguishing characteristic of the minuet. But if either the rythm is so contrived, or the musical cadences are so placed, as at any time to form combinations of three or of five bars, the piece then ceases to be a minuet. It may, however, notwithstanding this, be a pleasing composition. The modern musicians, especially those of the German school, often subjoin to the minuets of their instrumental pieces, airs of the same time and measure, which they sometimes call second minuets, but more frequently trios. In composing these trios, they sometimes take an opportunity of displaying their learning and invention, and of searching for novelty, without considering themselves as under obligation to adhere to the elegant simplicity of style, or the regular rythmical structure of the minuet. By this means, the hearer is for a while very agreeably entertained, and the beauty and peculiar qualities of the minuet, which is always repeated after the trio, are rendered more striking. In these airs, combinations of three bars are frequently to be found *. As, however, two of these combinations often occur in succession, and the other parts of the piece proceed commonly by pairs, the number of bars in the complete strain or air is in most cases even, or divisible by two.

IN pieces of considerable extent, such licences, when used with moderation, frequently pass without being greatly observed. They may even at times produce a very happy effect. They serve to rouse the attention of the hearer, which is apt to flag in a long piece, when the rythm uniformly proceeds by equal combinations ; and they often give a more emphatic in-

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roduction,

* TRIO of first minuet in third quartetto of HAYDN, first set. Trio of second minuet in second quartetto of the same author, second set.

introduction, or a more striking and distinct close, to some remarkable strain. In such pieces, the bars very frequently proceed by pairs. It is no unusual thing, however, for the composer, in the course of the piece, to invert the order of the pairs, or to construct the music in such a manner, as to lead the hearer occasionally to consider those bars as the first or leading bars of a pair, which, from the place in which they stand in the piece, ought to be accounted the second or following. This is done in various ways. When a strain, for instance, happens to close upon the beginning of an odd bar, in place of completing the time of the even bar which should follow it, by sound or silence, that strain is either immediately repeated, or a new strain is introduced *. When, again, a strain concludes upon the first of an even bar, the key-note, or one of its harmonics, with which that bar begins, is sometimes made the commencement of a new strain, and of course to stand as the leading bar of the next pair †. This is very often practised by the composers of instrumental symphonies, when it is intended by them, that the passage thus brought in should be sensibly different in loudness or in style from what went before. A bold and animated strain especially, in which all the instruments join and exert their whole power, is thought to produce a greater effect, when it is introduced in this sudden and abrupt manner. The arrangement of the pairs is also sometimes inverted, by the repetition of a bar in the middle of a strain. Such repetitions seem, upon some occasions, to give the appearance of greater bustle and confusion to music that is impetuous and rapid ‡. Lastly, the first bar of a movement, or of some particular

* ELEVENTH periodical overture, last movement, at the thirty-first bar.

† THE same movement at the forty-seventh bar, where the original arrangement of the pairs is restored.

‡ THIRD quartetto by HAYDN, first set, last movement, at the 15th bar of the first part, and the 29th bar of the second part.

cular strain in the progress of it, is sometimes occupied by the key-note, struck with emphasis, and followed by one or more feeble notes, introductory to the next measure. This first bar being as it were set aside, or considered as standing by itself, the music afterwards proceeds by regular pairs, commencing at the second bar *. When inversions occur at the end of three or of five bars, distinct combinations of these numbers are formed †. Such smaller uneven combinations are very often repeated, and thus the original arrangement is restored. In other cases too, when by any means the first arrangement of the pairs or double bars has been inverted, it is frequently restored either by the same or by some other means. Sometimes, however, the altered arrangement continues to the end of the piece, and the number of bars in it becomes thereby uneven. As pleasure is often heightened by variety and contrast, such occasional interruptions of uniform movement give an additional relish to the regularity that is observed in other parts of the composition. Their effect is somewhat analogous to that of discords in the harmonical structure of music.

THE licences with respect to the combinations of the bars, which have been mentioned above, though they seldom fail to strike a person who has a good ear, do not prevent the rhythm from being distinct and pleasing. In some musical compositions, however, such licences are carried to a greater extent. The combinations are sometimes so various and obscure, that the hearer can scarcely retain the impression of them. This is often the case in the longer and more grave and solemn pieces of what is now, by way of distinction, called the ancient music,

* FIRST quartetto of the same set, last movement, at the beginning, and first movement, at the 23d bar of the first part, and corresponding passage of the second part.

† THE first quartetto of HAYDN's second set begins with two combinations of three bars, after which the music proceeds in general by pairs. The second part of the last movement of the first of six overtures by the Earl of KELLY, begins with two successive combinations of five bars.

fic, and particularly in that species of it, which is known by the name of the fugue. This had its rise at the time when the chief professors and improvers of the musical art were churchmen, and when, of course, that kind of music was chiefly cultivated, which was thought to be best calculated to compose and elevate the mind, and to inspire devotion. A simple, regular and distinct rhythm was probably thought by them to give the music a light and airy cast, inconsistent with the effect which they wished to produce. They either made the movement flow and the notes equal, in which case the attention of the hearer was almost wholly directed to the tone and modulation; or if, in their instrumental music, they introduced a quicker and more varied movement, they studiously avoided every thing, which might have the appearance of regular air. The fugue seems to be well calculated to answer this intention. It is executed by two, three or more voices or instruments in concert. All of them in succession are made to sound some short simple melody, which is called the subject. This is frequently repeated or imitated by them, in a variety of different keys, the repetitions coming in at unequal intervals, and often in the middle of a bar. As the composition of the fugue was thought to be a great display of art and skill, it was afterwards introduced into every kind of instrumental music, and was gradually rendered more complicated. As the rhythmical combinations are often irregular and indistinctly marked, and the harmonical parts are frequently running counter to one another, it requires great attention to perform it with precision and accuracy, and of all music it gives least pleasure to one who has not been accustomed to it. The taste for this kind of music has been for some time declining, and it is now mostly confined to the church.

ALMOST every degree of irregularity, then, in the combinations of the bars may be occasionally tolerated. This, however, is by no means the case with the bars themselves, or the single

single parcels. Any inequality among them is more sensibly felt, and when improperly introduced, never fails to hurt and displease. Such inequalities may be made, either by increasing or diminishing the unit, thus making the movement quicker or slower, or by varying the measure, or the number, according to which the bars are formed. In a long piece of music, a considerable variety, both of movement and of measure, may be introduced. Changes, however, are seldom made, until the movement has gone on for some time, in one uniform movement and measure, and has been brought to a close more or less complete. Such changes, when skilfully managed, enliven the music, surprise the hearer, and excite his attention. When, however, they occur very often, and at small intervals, they never fail to perplex and confound. The hearer is kept in a state of continual suspense and uncertainty, and therefore cannot listen with satisfaction. The French musicians, rather perhaps in consequence of some fanciful theories, than from the suggestions of good taste, or the experience of agreeable effect, have sometimes introduced frequent and sudden changes of movement and measure into their pieces. Their example, however, has not been much followed. How often, or at how small intervals, changes of measure may be introduced into a musical composition, is a matter that is difficult to determine. It must depend a good deal upon the taste of men, and upon the habits which they may have formed. There is certainly, however, some limit, within which such changes cannot be made, without giving more uneasiness than satisfaction to the hearer. We may bear to be, in some degree, offended a certain number of times, when such offence has the effect to stimulate and surprise, and when it is quickly compensated by some striking beauty; but if the experiment is too often repeated, the end proposed will be defeated. The piece will become a motely assemblage of dissimilar and unconnected parts, and
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will communicate no sentiment but that of ridicule or of disgust.

To change the measure or the number of equal times in a bar, in the course of a short strain or rythmical clause, has, so far as I know, never been attempted by a modern musician, and probably would not be tolerated. And yet, if we are to believe the accounts, which have been transmitted to us by ancient authors, this practice was not unfrequent amongst the musicians of Greece. The verses, to which they adapted music, were often composed of unequal feet, such as trochees and spondees, which they respectively considered as measures of three and of four equal times, and these occurring sometimes alternately ; and we are told that the music rigidly observed the measure of the verses. If this was indeed the case, it is a singular fact in the history of music, to which perhaps no parallel has been found. After the many clear and express testimonies to the truth of that fact, which have been given by enlightened authors, who were natives of the country, and who may be supposed to have been well acquainted with, and to have had frequent opportunities of hearing that music, it may appear highly presumptuous to express the smallest doubt with regard to it. There are, however, some considerations which strongly incline me to indulge at least some degree of scepticism, and to suppose that nature, perhaps without their consciousness, might at times prevail over system.

I FORMERLY observed, that to count off alternate parcels of two and of three equal times, and thereby to form aggregates of five, is by no means impracticable ; but that it requires an uneasy effort of the attention, and that both the performer and the hearer feel a strong desire to have the even number of six times completed, either by a lengthened sound, or by a silence. I may here add, that neither is it impracticable to form alternate parcels of three and of four times, but that, as the number seven, the aggregate of these, is less agreeable and satisfactory,

factory, and less easily comprehended than five, and as it is nearer in proportion to eight than five is to six; the desire of completing, by some means or other, the number of eight times will be still stronger, and will not be resisted without a great and constant effort of the attention, and even some degree of force and constraint. The difficulty will be much increased, if the unequal measures do not occur periodically in regular succession, but are variously introduced in the course of different strains, without any fixed or permanent rule. In order that such unequal measures may be expressed with accuracy, it seems necessary, that the equal times of which they are composed, should be of such dimension as that they may be counted single. If they are too minute to be so counted, it will probably be impossible for the performer to mark with certainty, or for the hearer to perceive distinctly, the proportion which subsists betwixt the contiguous unequal bars; as there is no common measure or standard to which they may be referred, or by which they may be adjusted. It seems necessary, moreover, not only that the beginning of every measure should be distinctly marked, but also that every single interval of time should be rendered obvious, either to the eye or to the ear of the performer. Unless some such assistance is given to him, there is reason to apprehend, that he will not always execute the different bars according to their prescribed measures. We are told, that this was done in the performance of the choral music of the ancient Greeks. The coryphæus, placed in a conspicuous station, marked the arsis and thesis of the successive feet, while others struck with their hands, or with the points of their fingers armed with some hard body, each single time of which they were composed. If these single intervals were struck with perfect uniformity, and were regularly distributed among the different feet, according to their respective measures, we cannot avoid acknowledging, that, on many occasions, they did truly and accurately express contiguous unequal parcels of rythmical

times. We can only say, that they were at much pains to counteract a strong propensity of nature, in order to attain an object, the agreeable or happy effect of which we cannot now so much as conceive. But it may be asked, how are we certain that these single times were always struck in exact uniformity, or that the intervals marked by the strokes were in every case equal? It will possibly be answered, that there was sufficient security for this, in the strong natural propensity which all men feel to express such small times equally and uniformly, when it is not their professed intention to do otherwise. But surely the natural propensity to assemble these times into equal parcels is also strong, perhaps, in some cases, stronger than the other. When these two propensities, then, are set in opposition to one another, it becomes a question which of them is most likely to prevail. We are told, that, in the performance of the Greek music, the propensity to the equable expression of single times prevailed, and that the parcels or aggregates of them were unequal. It is certainly, however, not unnatural to suppose, that sometimes the other propensity might preponderate, and that some inequality might be admitted amongst the smaller times, which were marked by the crepitacula, in order to bring the feet or parcels more nearly to equality. These times and measures were not marked by machines, so constructed that they could never vary, nor by persons who had no thought nor concern, but to strike with the hand or fingers at equal intervals of time. The coryphæus, who regulated and conducted the performance, must be supposed to have been a musician of distinguished talents, and the smaller times were marked by performers, who were keenly engaged in the business that was going forward, who probably sounded every note of the music, and articulated every syllable of the verse. It has always appeared to me very wonderful and unaccountable, that the delicate ears of the ingenious and enlightened Greeks should not only bear, but even be delighted, with what a modern cannot
hear

hear without pain and disgust ; and I would very willingly suppose, that they made some such accommodation as is hinted at above in the performance of their music, and that their feet or bars were sometimes unequal, more in theory than in practice. When we consider the rythmical constitution of man, which, being a part of his nature, must be fundamentally the same, in all ages and amongst all nations ; when we consider that these Greeks had a very lively feeling of the powers of rythm, and that they were accustomed to have equal measures frequently presented to them in their most popular compositions ; lastly, when we consider, that they had no written characters to represent some of the proportions which may enter into the simplest music, particularly that which is marked by the point in the modern notation, and therefore could have no distinct perception of those proportions, or rather might occasionally express them, without being conscious of their doing so ; it does not seem impossible, or even improbable, that their practice upon many occasions was not conformable to their theory, and that they might actually express as equal those measures, which, according to rule and system, were unequal. After all, it is impossible to say, how far the power of habit may operate upon men in this as well as in every thing else. It must be acknowledged, that there are various circumstances in the musical system of the ancients, besides the one that we have been now treating of, which we must be satisfied with contemplating and admiring at a distance, without hoping fully to understand them, or daring to imitate them.

To conclude this part of the subject, the last deviation that can be made from regular rythm, is varying the length of the unit or single time in the same bar. This has never been attempted in written music, and can hardly be done without almost entirely destroying every impression of rythm or measured sounds.

THE regular structure of rhythm, and the progressive deviations from that structure, which I have above endeavoured to describe, have been chiefly considered as taking place in music. The same things, however, to a certain extent, may be found in poetry; and many of the observations which have been made upon them may be exemplified from verses, and may serve to illustrate some particulars in their structure. A verse is an assemblage of words, which are so arranged, as that the long and short, or the strong and feeble syllables of which they are composed, may, by their succession, give a rhythm, such as I have described, more or less regular. It must, therefore, be so constructed, as that the hearer may be led to form the equal or nearly equal times, which are marked by the syllables, into certain parcels and combinations. The ancients seem in general to have considered the time of a short syllable, as the unit or first element of the rhythm of poetry. According to this supposition, the feet will become analogous to the bars or first parcels in music, the verse will be analogous to a combination or strain, and the stanza, where it occurs, will represent the entire piece, which being finished, the same rhythmical air, as it may be called, is again repeated. The time in which a short syllable is expressed in reciting verses, is often too small to be regularly counted and parcelled. If this is thought to be the case, the feet may be considered as units, variously divided and articulated by the different syllables which enter into them; the verse will then correspond to a bar, and the stanza to a combination. Although, however, the time in which we utter a foot is frequently not greater than what we are disposed to consider as an unit in music, yet, as it is always composed of two or more smaller intervals, and as we have frequent opportunities of hearing it prolonged in singing, so as to fill up the time of a bar in music, we are hence rather more disposed to consider the foot as a short parcel or bar, than as a divided unit. The former

mer analogy, therefore, will perhaps be the most simple and obvious, and the most easily applied.

THE measure of a verse, or the number, according to which it is intended that the combinations should be formed, may be easily intimated to the reader, by writing them in separate lines. This contrivance, however, can be of no service to the hearer. Some other means must be used to direct his attention to the number proposed, or to make him stop and begin anew, after that number of equal times has been expressed. The very name of verse implies a return. I formerly mentioned three different means by which this may be effected, namely, the return of similar combinations and divisions of the times, or, in other words, the return of similar arrangements of long and short sounds, the return of sounds similar in kind or in quality, and pauses. All these means have been employed in constructing verses.

THE return of similar successions of long and short syllables at equal intervals, naturally leads the hearer to account the times which have been expressed during one of those intervals, as one parcel or combination. This similarity may either take place through the whole line, or only in a particular part of it. In the first case, when each single combination is exactly similar throughout, or, in the language of the grammarians, when every line contains the same number of feet disposed in the same order, the return is abundantly clear and obvious, provided the succession of long and short, or of strong and feeble syllables in the measure, be in any degree diversified. We have an example of this in the asclepiadæan verses of the ancients. Such measures seem to have been considered by them as deficient in variety, and proper only for short pieces. HORACE has been very sparing of them. Of all his odes, there are only six, in which every line is scanned by the same feet taken in the same order. When the cadence of the line, or the arrangement of the syllables, is such as to strike the hearer, or engage his.

his attention, the frequent repetition of it, like the frequent repetition of a short musical strain, can hardly fail to be in some degree irksome and disgusting. The other case, in which the similarity takes place only in a part of the line, is more consistent with variety. We have the most distinct impression of a return, when the similarity occurs at the end of the line. Of this we have a striking example in the common hexameter verse of the ancients. The dactylus and spondæus, recurring regularly at equal intervals, necessarily leads the hearer to consider those intervals as distinct combinations of equal times, although the same feet be disposed in the other parts of the measure in every possible way. The iambus recurring at the end of iambic verses, when distinctly pronounced, will give some impression of a combination, when the rhythm in the other parts of the line is very irregular. Other instances of the same kind will readily occur. Sometimes the most striking similarity takes place in the middle of the line. The dactylus, in the middle of the sapphic verse, seems to have the chief effect in forming the return of that measure.

WHEN the return of the verse, or the impression which the hearer has of distinct combinations, is to depend chiefly upon such similarities, it is necessary, that the cadence in that part of the line in which the similarity takes place, be marked, and easily distinguishable from that of the other parts, or that the verse be made up of some diversity of feet. When lines run uniformly by the same, or nearly the same feet, as in trochaic and iambic verses, no such distinct recurrences can happen. In this case, some other means must be used to give the hearer the impression of a combination. A very gentle hint will incline a hearer to count off such feet by combinations of the smaller even numbers. For this, little more is necessary than to write them out in separate lines. The tones of voice, with which a person is disposed to read lines of such even measure, are often sufficient to direct the hearer to the number according to which they

they are formed. This effect is more certainly obtained, when the verse is made to consist of an uneven number of such feet, together with an additional syllable or cæsura. As it is thus deficient of the even number by one syllable, the reader is naturally disposed to fill up the time of that syllable, either by pausing at the end of the line, or by prolonging the last or the penult syllable. In either way, he conveys to the hearer a very distinct impression of the measure. Such catalectic verses, as they are called, occur frequently in the works of the ancient poets.

VERSES of the trochaic and iambic kind are often composed of some uneven number of feet, without such additional syllable. Our common English verse of ten syllables is of this form. In this case, there seems to be no rythmical means of giving the hearer an impression of the measure, but pausing a little at the end of every line. Such uneven measures naturally infer a pause. If the reader, while reciting a line, catches the idea of regular pairs, he will be disposed, by resting at the end of the line, to complete the time of his last pair. This, however, is attended with inconveniencies. The hearer is made to depend for his impression of the combination, chiefly upon the accuracy of the reader. If the latter neglects to make the proper pauses, the former may lose this impression, and may be equally disposed to form combinations of any other number. On the other hand, when there is no grammatical stop at the end of the line, when a clause of a sentence is continued from one line to another, such pauses are ungraceful; the reader, if he is more attentive to the sentiment than to the rythm, always makes them with reluctance. In such cases too, to mark the end of the line by a particular inflection of the voice, is very improper; and it is difficult to observe pauses without making such inflection.

THESE inconveniencies seem to furnish objections to our English blank verse, which is exactly of the nature that I have been describing.

scribing. This perhaps cannot with strict propriety be called verse; it wants one of the essential characters of verse, a distinct return. The feet indeed mark times, which may be expressed as equal; but there is no circumstance in the rhythm to lead the hearer to form these times into combinations of any one number in preference to another, besides the mere artifice of writing the intended combinations in separate lines. It is impossible to read it, so as to maintain in the hearer the impression of the combination, without often doing violence to the sense, by separating words which ought to be united. One may be easily satisfied of this, by reciting the first sentence of MILTON's *Paradise Lost*, in which almost every line terminates in the middle of a clause. In reading such passages, the pauses must often be omitted, and the measure sacrificed to the sense. This verse, however, if it may be called such, has been thought to be of all others the most proper for poems of considerable extent, upon subjects that are great and dignified: The seeming imperfections, which have been stated above, are perhaps the circumstances which contribute to render it so. The alternate succession of long and short, or of strong and feeble syllables, which generally takes place, gives a smoothness and a regular flow to the language, which sufficiently distinguishes it from prose, while, at the same time, it does not solicit the attention so strongly, as to render frequent repetition disgusting; and the deviations which are occasionally made from that arrangement, give a variety to the cadence, and often a very happy expression to particular passages. The proper measure of the verse, or that which seems intended by the poet, is often obscured, and even changed, by the different breaks or divisions which occur in the lines, and by the continuation of grammatical clauses from one line to another. The unequal combinations of the feet, however, which are thus formed, like the obscure and unequal combinations of the bars in an extended piece of serious music, both give a variety, and add a dignity and solemnity

nity to the movement, which it could not possess, if the combinations were always distinct and equal; and the frequent occurrence of lines, in which the measure of the verse is clearly marked, prevents the hearer from losing sight of it, and also communicates additional pleasure from the contrast. This mode of composition seems thus to unite the freedom, variety and energy of prose, with the softness and elegance of verse.

IN lines of such uniform cadence, there is no means more simple, or more effectual for giving the impression of regular combination, than the return of similar sounds. When two contiguous verses, of equal times, are terminated by one or more syllables of the same or nearly the same sound, the hearer can find no difficulty in adopting and going along with such combinations. This contrivance has been called rhyme. It is said to have had its rise from a corrupted taste during the ages of ignorance and barbarism. It still continues, however, to be practised by the best poets, who write in the modern languages; and perhaps the constitution of such languages does not afford a better means of constructing regular verses.

IN poetry, verses may be formed according to the model of what I called regular and perfect rhythm, so as to give the impression, not only of equal parcels and combinations, but also of distinct aggregates of those combinations. When such aggregates consist of two single combinations, they are called couplets, when of more than two, they get the name of stanzas. We are led to form such aggregates by the same means, by which we are led to form the single combinations, namely, by the return of like cadences, by pauses and by rhyme. When two contiguous lines rhyme together, we have the impression of a couplet; when the alternate lines rhyme together, we form a combination of four. The same impressions may also be conveyed by other means more purely rhythmical. When the lines are all equal, and made up of the same or equal timed feet, and the stanzas consist uniformly of four or eight

lines, we have then a rythm perfectly regular, corresponding to the minuet or march time in music. Such regular structure is not always observed. In the higher kinds of lyric poetry, it is thought to be inconsistent with that freedom and variety, and a check to that fire and enthusiasm, which ought to characterise those compositions. Accordingly, the writers of lyric poetry have departed the farthest of any from this regular structure, and have indulged themselves in almost every kind of licence. The lines, of which stanzas are composed, may often consist of an unequal number of syllables, whilst the times employed in reciting them are strictly equal, the deficiency of the shorter ones being compensated by pauses, or by lengthened sounds. Sometimes, however, the inequality is so great, as to render such compensation impracticable. Such unequal lines, like unequal combinations in a musical air, when properly introduced, may communicate a spirit and variety to the stanza, and give it a more marked and striking conclusion. The adonian verse, coming after three sapphic lines, gives an agreeable variety and a graceful close to the stanza. Amongst the ancients, there are few or no instances of stanzas, consisting of more than four lines. The moderns, by the help of rhyme, are enabled to form larger and more variegated stanzas.

So long as all the lines of a stanza are composed of the same or of equal timed feet, the rythm may be considered as in some degree regular. Thus the hexameter and the faliscan verse form an agreeable couplet.

Laudabunt alii claram Rhodon, aut Mitylenen,
Aut Ephesum, bimarifve Corinthi.

The elegiac couplet is of the same kind. The pentameter verse is indeed considered as an uneven combination. When, however, it regularly divides into hemistichs, the pauses, which we are disposed to make at the cæsuras, fill up the whole time of
the

the hexameter. Trochaic and iambic verses may be combined into couplets in the same manner. When the trochaic verse is catalectic, the deficient time at the end is made up by the first syllable of the succeeding iambic, and the whole combination proceeds as if it were trochaic.

Non e|bur, ne|que aure|um
Me|â re|nidet | in do|mo la|cunar.

The latter of these two combinations being uneven, the reader will be disposed to pause at the end of it, during the time of an entire foot, and will be gratified, when the structure of the sentence permits him to do so. The passion for variety, however, could not always be confined within this limit. In the works of the ancients, we meet with couplets and stanzas, of which the different lines are composed of different and unequal timed feet. This is a further departure from regularity. It is like varying the measure of the bars in a piece of music. One of the most striking examples of this is, when couplets are formed of hexameter and iambic verses. Although such licence may not have the same disagreeable effect in poetry, that it often has in music, it seems at least to give an impression of incongruity, which is probably heightened by the constant recurrence of the different measures at stated intervals. The solemn and majestic movement of the hexameter does not seem to assort well with the airy flippant pace of the iambic. After pronouncing the latter, a person requires some time to recover that firmness of tone and manner, with which he is disposed to pronounce the former. The 16th epode of HORACE is composed in couplets of hexameter and senarian iambic verses, and is the only instance of this measure, which occurs in his works. In this piece, the contrast is very striking. The even lines throughout the whole of it are pure iambs, which have a more rapid movement than those which are mixed. The verses

of the Phaleucian form may be considered as short couplets of the same kind.

A FARTHER deviation from regularity is when such unequal timed feet are admitted into the same line. The mixed iambic and trochaic verses of the ancients furnish us with the most remarkable instance of this. I formerly ventured to express a conjecture, that in the performance of the music, which was adapted to verses of this kind, the ancients, by some means of accommodation, of which they were not distinctly conscious, might occasionally express as equal those contiguous feet, which, according to rule and system, were unequal; in other words, that they sometimes departed from the proportion of two to one, which they established as subsisting betwixt the long and short syllables of words. It seems still more probable, that they did this when reciting such verses. It is indeed difficult for us to conceive how they could do otherwise. In singing, they might be assisted in expressing those unequal measures with accuracy, and even, in some degree, constrained to do so, by seeing the arsis and thesis of each foot distinctly marked, and hearing the single times uniformly struck; but they could not always have the same assistance, when reciting. The time of a short syllable might be counted and parcelled, when expressed in the continuous and more extended tones of music; but this could scarcely be done with ease and certainty in common speech; and, without this, it is not easy to discover, how the proportions of those unequal feet could be accurately expressed or perceived. I should, therefore, be apt to suppose, that the propensity to equal parcels or measures of syllables would prevail, as it might be gratified almost insensibly, and as there appears to be nothing of sufficient force to counteract it. It is often difficult to determine exactly the proportional quantity of contiguous syllables, or to lay down any particular proportion as invariably subsisting betwixt them. We can sometimes articulate three, perhaps even four syllables, in our own language,

in

in no longer time than we employ in expressing one syllable in the same sentence. It would be rash, however, upon perceiving this, to assert, that the one syllable was in quantity triple or quadruple of the others, as in different occurrences, or in different arrangements of the same syllables, the proportion might be varied. We can, with great ease, contract or extend a syllable, when we wish to make it a certain component part; or the whole of a determined interval of time, upon which we have fixed our attention. It is hard to suppose, that in the Greek and Latin languages, which are composed of the same simple elements with ours, no proportion should subsist betwixt contiguous syllables, but that of equality, or that of two to one, or some obscure or ill defined proportion approaching to these; and it is still harder to suppose, that these proportions were constant and invariable, in every situation and occurrence.

THE trochæus and spondæus might be rendered equal in recitation, either by contracting the latter to the time of the former, or by extending the former to that of the latter. The one or the other of these practices might be adopted in different cases, according to the different structure of the syllables of which the feet were composed. That there was a tendency to prolong the trochæus, we are almost inclined to believe, from the first syllable of that foot being regularly placed in the strongest and most emphatic part of the measure. It is well known, that in constructing mixed trochaic verses, the trochæus was made to occupy the first, third and other uneven places; the even places were occasionally filled with spondæus, or other feet of four times. In iambic verses, again, the even places were kept sacred to the iambus. If, however, we consider the first syllable of these verses as introductory, and suppose the measure to begin with the second syllable, which we are much inclined to do, we reduce them to trochaics, in which also the trochæus will be regularly found in the uneven places of the measure.

IT is not always safe indeed to reason from general principles and analogy upon matters of fact, more especially when such reasoning appears to be contradicted by positive testimony. I therefore offer these conjectures with diffidence. The accent and manner of pronunciation of the ancients being now irrecoverably lost, we have no means of having the matter subjected to sensible demonstration. All that we can say is, that if they did in fact pronounce these unequal feet in their just proportions, and were conscious of doing so, they possessed a power of combining very small intervals of time into unequal parcels, to which perhaps no parallel can be found in modern days.

IV. *On certain ANALOGIES observed by the GREEKS in the Use of their LETTERS; and particularly of the LETTER ΣΙΓΜΑ. By ANDREW DALZEL, M. A. F. R. S. EDIN. and Professor of Greek in the University of EDINBURGH.*

[Read by the Author, Dec. 19. 1785, and Nov. 19. 1787.]

INTRODUCTION.

THE power of pronouncing articulate sounds is one of the most obvious marks which distinguish man from the other animals. No philosophical investigation is necessary for pointing it out, and therefore it has not escaped the notice of the poets, the most ancient of all authors. In the works of HOMER and HESIOD*, we often meet with the expression μέροπες ἄνθρωποι, *men having an articulate voice*; the word μέροψ being evidently compounded of μέρω, *to divide*, and ὄψ, *the voice*†.

BUT

* Vide *Iliad*. ε', 250. γ', 402. ε', 288. Ὡς. *Oper. & Dies*, 109, 142. ANACREON has also made use of the same epithet, but without the substantive; *Od.* III. 4.

† Διὸ τὸ μεμερισμένην ἔχειν τὴν ὅπα, says HESYCHIUS, *voce μέροπες*. In which SUIDAS agrees. EUSTATHIUS is more explicit. Μέροπες οἱ ἄνθρωποι, παρὰ τὸ φύσει μεμερισμένην ἔχειν τὴν ὅπα εἰς τέλειους καὶ εἰς συλλαβὰς καὶ εἰς στοιχεῖα, ὃ μηδεμία τις ἄλλη ἔχει φωνὴ παρὰ τὴν τῶν ἀνθρώπων αὐτὴν. *Men are called μέροπες, from their naturally having their voice divided into Words and Syllables and Elements, a quality which no voice possesses, except human Speech.* Ad *Iliad*. ε', 250. The Bishop adds, That "those of his own sacred society, the interpreters of holy Writ, derive the word from the division of tongues which took place at the building of the tower of *Babalana*," as he calls it; which etymology ERASMUS has also taken notice of in his *Dialogue de recta Latini Græcique Sermonis pronuntiatione*.

BUT although man is plainly possessed of this faculty of articulation, or pronouncing distinct syllables; yet the analysis of those syllables into their constituent parts, or simple elements, or into what the Greek writers call *στοιχεῖα*, must originally have been a work of immense ingenuity. Perhaps it would even have been impracticable ever to have made a complete analysis of this kind, without the invention of visible signs for denoting each of those elements. Nor hath any sort of signs, symbols or characters been found so proper for that purpose, as those which we call *Letters*. Indeed, it seems impossible to comprehend any other visible mode of analyzing words into syllables, and syllables into simple elements, than that which is furnished by letters. For though we can conceive language to be, in some degree, conveyed by marks of imitation; as when, in expressing *an elephant*, we should set down the figure of that animal: yet we could never analyze such a representation, so as to convey any idea of the different syllables in the word *elephant*, or of the elemental sounds of any of those syllables*.

INDEED, the significant sounds of a language, even considered each in the aggregate, and without any resolution into its
constituent

nuntiatione. But of this derivation, DAMM, in his *Lexicon*, justly says, “*Id piè magis quam verè.*” EUSTATHIUS has farther observed, “*That certain birds are called “μῖμοις;”* those, no doubt, he means of the parrot kind. But the manner in which these possess the faculty of articulation, forms but a very slight exception to this characteristic of human nature. Human articulation was defined by the Stoics as follows: *Φώνη ἑναρθρος καὶ ἀπὸ διανοίας ἐκπεμπομένη*, *Sound articulate, and proceeding from Sentiment*. See HARRIS’S *Hermes*, p. 322.

* EVEN DR WILKINS’S *Real Character*, which he has, with such astonishing labour, invented, is not calculated to give any idea of syllables or elemental sounds; and therefore, in order to complete his scheme of an universal philosophical language, he has likewise invented two alphabets, one of which he calls a *Natural Character*; this being necessary for the expressing of proper names, according to his project. See *An Essay towards a real Character and a philosophical Language*, by JOHN WILKINS, D. D. *Dean of Ripon, and F. R. S. (afterwards Bishop of Chester.)* Lond. 1668. fol.

constituent elements, can be but very imperfectly expressed by figures of imitation ; because there is of these sounds an immense variety, which cannot possibly admit of any such visible exhibition *. Those conventional signs, which we call letters, are the only proper and complete mode of denoting simple elemental sounds, and their infinite variety of combination in syllables and words. For although the alphabet of no one language contains a sufficient number of letters to express every possible modification of articulated sound ; yet the letters composing the several alphabets of those written languages with which we are acquainted, especially the ancient Greek and Latin, have been found sufficient for denoting all the requisite elementary sounds in those particular languages †.

LETTERS are called by the Greeks *γράμματα*, a word whose etymology is evident ; for if *γράφω* signify *to write*, *γράμμα* must signify *a thing written*, that is, a letter, or written character, denoting an element of articulate sound ‡. The ori-

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* SEE an excellent account of the difference betwixt imitative and symbolic language, by the late Mr HARRIS, supported by quotations from Greek authors. *Hermes*, Book III. Chap. 3.

† Dr WILKINS has endeavoured to shew the defects in common alphabets, as to the true order of the letters, their just number, determinate powers, fitting names, proper figures, &c. *Essay towards a real Character*, &c. Part I. Chap. v. And he has exhibited a table of such simple sounds as he thinks can be framed by men, with a twofold instance of a more regular character for the letters, together with several other curious particulars. Part III. Chap. x. xi. xii. xiii. xiv. After all, he concludes as follows : “ These thirty-four letters, before enumerated, will suffice to express all those articulate sounds, which are commonly known and used in these parts of the world. I dare not “ be over-peremptory in asserting, that these are all the *articulate Sounds*, which either “ are, or can be in nature ; it being as impossible to reckon up all such, as to determine “ the just number of *Colours* or *Tastes*.”

‡ THE etymology of the Latin word *Litera*, is not so well ascertained. See SCALIGER *de Causis Ling. Lat. Lib. I. Cap. 4.* AMMONIUS the Grammarian thus defines the difference betwixt *γράμμα* and *σφίχθον*. *Γράμμα* Στοιχείον διαφέρει. Στοιχείον μὲν γὰρ ἔστιν ἡ ἐκφώνησις καὶ ὁ φθόγγος, ὃ τὸ γράμμα ἐστὶ σημεῖον ἢ τύπος ἢ εἴδω. *Γράμμα* differs from *σφίχθον*. For *σφίχθον* is the enunciation and the sound, of which *γράμμα* is a sign or type or figure. De affinium vocab. differentiâ, voce *γράμμα*, ubi vide quæ annotavit vir doctissimus LUN.

CASP.

ginal signification, however, of γράφω was not precisely what we now mean by the expression *to write*. In the earliest times of the Greek language, it meant *to carve*; and as the most ancient method of writing was to carve some sort of figures upon tables of wood or brass, which was expressed by γράφειν, (as we learn from HOMER *), that verb remained in use to express the

CASP. VALCKENAER. ARISTOTLE gives the following account of an element. Στοιχείον μὲν ἔν ἐστι φωνὴ ἀδιαίρετος* ἢ πᾶσα ᾗ, ἀλλ' ἐξ ἧς πέφυκε συνεστὴ γινώσκει φωνή. καὶ ᾗ τῶν θηρίων εἰσὶν ἀδιαίρετοι φωναὶ οὐ ἐδιμίαν λέγω στοιχεῖον. *An Element is an indivisible sound; not every indivisible sound, but from the composition of which an intelligible sound [or word] is naturally produced. For the cries of wild animals are indivisible sounds, but I call none of these an Element.* De Poetic. cap. xx. See also DIONYS. Halicarn. de Compos. Verb. cap. XIV. et PLATO in Cratylō. Vol. I. p. 426. Edit. SERRANI. See the Stoic definition of an element, quoted by Mr HARRIS from DIOGENES LAERTIUS: *Hermes*, Book III. chap. 2. But though γράμμα and στοιχεῖον are clearly different, the one signifying a letter and the other an element, they are frequently confounded by the Greek writers; the sign being often taken for the thing signified. Accordingly, DIONYSIUS the Thracian, in giving the etymology of the words, has confounded their meaning. Γράμματα δὲ λέγεται διὰ τὸ γραμμαῖς καὶ ξυσμαῖς τυπῶσθαι. γράφαι γὰρ τὸ ξύσαι παρὰ τοῖς παλαιοῖς, ὡς καὶ παρ' Ὀμήρῳ. [Iliad. λ', 388.] Τὰ δὲ αὐτὰ καὶ στοιχεῖα καλεῖται διὰ τὸ ἔχειν στοιχοῖν τινα καὶ τάξιν. *They are called γράμματα, on account of their being formed by lines and incisions: for γράφαι, among the ancients, signified to make an incision, as we find from HOMER, [Iliad. λ', 388.] The same are called στοιχεῖα, because they are arranged according to a certain progression or series.* Ars Gramm. apud FABRICIUM in Biblioth. Gr. Vol. VII. p. 27. Nor has THEODORE GAZA attended to the distinction in his definition, though it is, in other respects, extremely accurate. Δρετὶον δ' ἔσται ἀπὸ τῶ πρώτου, εἶν τῶν στοιχείων. ταῦτα γὰρ ἡ πρώτη καὶ ἀμερὴς ἐστὶ. τ' ἀνθρώπῳ φωνή, ἢ γὰρ ὡς ἔτυχεν συμπλέκεται ἀλλήλοις εἰς σύστασιν συλλαβῆς, ἀλλ' ὡς καὶ τῆνομα δηλοῖ, στίχῳ τε καὶ εὐτάκτως κινούμενά πως συντάσσεται κατὰ λόγον. *Perhaps we should begin with the first, viz. the Elements. For they are the first and indivisible voice of man; not being connected together at random, to produce the composition of a syllable; but, as the name imports, arranged in a rational manner, advancing in a certain series and regular order.* Grammat. Inst. Lib. IV. PRISCIAN has remarked this confounding of an element and a letter: “Abusivè tamen et elementa pro literis et literæ pro elementis vocantur.” Lib. I. In most cases, however, no great inconvenience arises from the neglect of this distinction.

* Πίμπε δὲ μιν Λυκίῳδε, πόρεν δ' ὅγε σήματα λυγρὰ,

Γράψας ἐν πίνακι πτυκτῷ θυμοφθόρα πολλά. Iliad. ζ', 168.

which, translated literally, runs thus: *He sent him into Lycia, and he moreover gave him destructive signs, having carved, upon a folding tablet, a variety of them fatal to his life.* The poet is speaking of PROETUS, who sent BELLEROPHON into Lycia with this fatal tablet.

the more commodious method of writing which was afterwards invented.

IN whatever part of the world, or at whatever time, the use of letters took its origin, (for I do not mean at present to enter upon that inquiry *), it cannot be denied that it is one of the most admirable of all human inventions. That we should be able, by means of twenty-four visible characters, to denote the various thoughts of our minds, uttered by articulate sounds, so as not only to convey them to persons absent and at a distance, but even to transmit them to posterity, must, if it did not, as some suppose, proceed immediately from the Deity, be considered as the most eminent of all the improvements which human art has yet made of those powers which he has been pleased to bestow upon our species †.

P 2

INDEED,

tablet. We have no authority to translate *σίματα*, *Letters*, or *γράφας*, *having written*, as is generally done. Indeed, no where in the poems of HOMER, do we find any part of the simple verb *γράφω*, except here, and in the 599th line of the 17th book of the Iliad, where *γράφει* occurs; and there it signifies *to wound*, or *to make an incision*, being applied to what the spear of POLYDAMAS did to PENELAUS the Bæotian. Its compound *ἐνγράφω* indeed is found four or five times, and always signifies *to raze* or *graze* the skin with the point of a weapon. But neither *γράφμα* nor *γραφή* are to be met with in HOMER, nor does he any where make mention of Letters or writing by any terms whatever. For *σίμα*, which occurs so often, can scarcely ever be said to signify what we mean by a *Letter*: And hence an argument has been adduced, though not by any means a decisive one, against HOMER's knowledge of the art of writing; or the use of letters. But this is an investigation which cannot properly be introduced in a note. See what the late Mr ROBERT WOOD has written upon this subject in the last section of his *Essay on the original Genius of HOMER*. Lond. 1775. 4to.

* SEE a short but elegant Dissertation, printed at the conclusion of the 2d Vol. of HAVERCAMP's *Sylloge Scriptorum qui de Ling. Græc. verâ et rectâ pronuntiatione commentarios reliquerunt*, entitled, *De Fanicum Literis*, &c. GUILLIELMO POSTELLO Barentonio auctore. See also HARRIS's *Hermes*, Book III. ch. 2.

† “ LA communication des pensées par l'Ecriture, n'est guères moins admirable que celle qui se fait par la Parole. Ce ne fut apparemment qu'après bien des meditations et des essais multipliés, que degouté des difficultés, des équivoques, des obscurités, des bornes trop étroites de l'Ecriture hiéroglyphique, l'inventeur de l'Ecriture littéraire reconnut

INDEED, the faculty of speech itself, not to mention the various arts and sciences, could not have been brought to any considerable degree of improvement, without the assistance of written language. Without this, the knowledge of one age of the world could not have descended distinctly to another, and consequently mankind must, in a great measure, have lost those advantages which they derive from the accumulated experience of former times.

THE variety of languages, however, both written and spoken, which takes place in the world, has been matter of regret to those who have considered the subject particularly; and it has been wished, that a method of speech, capable of being conveyed by writing, had been invented, which mankind, at least in every polished nation, might have been able universally to adopt and to understand. But the distribution of the world into so many different kingdoms and nations, seems to render the introduction of an universal language among mankind quite impracticable*. For although men possess

“ connu le nombre assez petit des sons élémentaires, et comprit qu’en les représentant
 “ par autant de caractères distincts, on pourroit combiner ces caractères comme les sons
 “ qu’ils représentent; ce qui constitue en effet

“ ————— *Cet art ingénieux*

“ *De peindre la parole, et de parler aux yeux;*

“ art merveilleux, qui fixe à jamais la parole et la pensée qu’elle exprime, qui porte
 “ l’une et l’autre aux absents, qui les fait passer à la postérité la plus reculée, et dont on
 “ peut dire avec vérité et sans restriction, ce que dit M. DIDEROT d’un idiome qui di-
 “ viendrait commun à tout le genre humain: [*Encyclop. au mot ENCYCLOPÉDIE.*] que
 “ par son moyen, la distance des temps disparaît, les lieux se touchent, il se forme des liaisons
 “ entre tous les points habités de l’espace et de la durée, et tous les êtres vivants et pensants
 “ s’entretiennent.” *Grammaire Generale, &c. Par M. BEAUZEE. Tom. I. p. 2. See*
 also CICERO. *Quest. Tusc. Lib. I.* and WILKINS’s *Essay, &c. p. 10.*

* THE ingenious, laborious and truly admirable effort of Dr WILKINS, to invent and establish an universal character and philosophical language, has only tended to show more strikingly the impracticableness of such an attempt: At least, however feasible his project may appear, his method still remains unemployed by the learned; and as for the vulgar, it is quite beyond their comprehension.

possess universally the same organs of speech, and, by means of these, the same faculty of uttering articulate sounds; yet the manner of exerting those organs, so as to produce a particular language, being quite arbitrary, is a work, at first, of accident, and then of gradual improvement, and which cannot be carried forward, even by the help of writing, without a frequent intercourse, and a sort of mutual convention among the individuals of that society, who find it for their advantage to adopt such a language*. But an intercourse adequate to such an end cannot take place beyond a particular nation; therefore an universal living language cannot possibly subsist: For, according to an observation of D'ALEMBERT, "There is nothing, " either in nature or in reason, which determines an object to " be designed by one sound more than by another." To which BEAUZEE adds, That "there is nothing in nature or reason " which determines a sound to be designed by one letter more " than by another†." Accordingly, a variety of different
tongues:

* THE inhabitants of some nations, says M. DU MARSAIS, employ certain organs, and even certain parts of organs, of which others make no use. There is likewise a particular form or manner of exerting the organs, &c. "Il y'a des peuples qui mettent en " action certains organes et même certaines parties des organes, dont les autres ne font " point d'usage. Il y'a aussi une forme ou maniere particuliere de faire agir les organes. " De plus en chaque nation, en chaque province, et même en chaque ville, on s'enonce " avec un sorte de modulation particuliere; c'est qu'on appelle *accent national*, ou *accent " provinciale*." *Encyclop. au mot CONSONNE.*

† "SI, comme le dit l'illustre Secrétaire de l'Académie Française, il n'y a rien " dans la nature ni dans la raison qui détermine un objet à être désigné par un " son plutôt que par un autre; on peut dire avec autant ou plus de vérité, qu'il n'y a " rien dans la nature ni dans la raison qui détermine un son à être désigné par une lettre " plutôt que par une autre." *Gramm. Generale, par M. BEAUZEE. Tom. I. p. 179.*
See also p. 233, 234.

Dr WILKINS indeed has endeavoured to contrive a set of characters, which, in their shape, have "some resemblance to that configuration which there is in the organs of " speech upon the framing of several letters." Upon which account, he thinks, such an alphabet may deserve the name of a *natural character* of the letters. *Essay, &c. p. 375.* But here he has not been very successful; and indeed he seems himself to prefer another alphabet, which he has also set down, although it has no such property, and yet is, as he confesses, "more facile and simple."

tongues has prevailed ever since the early ages of the world; and such of them as have ceased to be spoken would have soon perished, had they not been committed to writing; by which means, some of them have survived the wreck of nations, and the other vicissitudes of human affairs. Of these, though their genuine pronunciation be now, in a great measure, lost, we are still able, after a considerable degree of pains, not only to understand the meaning, but even to perceive the beauties; and, among the various sorts of instruction which they convey, we derive from them many essential advantages in improving and polishing our own language.

To none have we been more indebted in these respects, than to the language of the ancient Greeks. As this is acknowledged, by all who have studied it, to be the most perfect*; so the analogy perceived from an attentive observation of its structure, even in the most minute parts, is of all others the most complete and beautiful. Whence the Greeks borrowed their alphabet, which they used with such success, I am not here to enquire. That it did not originate with themselves, is universally agreed among the learned†. But it is no less certain,

* SEE Mr HARRIS's elegant encomium of the Greeks and their language, of which he was the great and rational admirer. *Hermes*, Book III. Chap. 5. Also, Dr GREGORY SHARPE, in the Preface to his *Origin and Structure of the Greek Tongue*.

† IT is the uniform opinion of ancient authors, that the Greek alphabet at first consisted only of sixteen letters, which were imported out of Phœnicia into Greece by the celebrated CADMUS. [See HERODOT. *Terpsichor.* cap. 58. PLUTARCH. *Sympos.* lib. 9. IREN. lib. I. cap. 12. LUCAN. *Phars.* lib. III. See also, Dr WILKINS's *Essay*, p. 11.] These sixteen letters, called *καδμυία γράμματα*, and sometimes *σηματα καδμυ*, were the two short vowels with the three *ancipites*; the three smooth and the three intermediate mute consonants; and the four liquids, with the solitary *Σίγχα*. PALAMEDES is said to have added the three aspirated mutes, and the double consonant *Ξι*, at the time of the Trojan war. And SIMONIDES is supposed afterwards to have invented the two other double consonants and the two long vowels. See MONTFAUCON. *Palæogr. Gr.* p. 115, 116, 117. And see an enumeration of the authors who have written on this subject in THEOPHILI CHRISTOPH. HARLES *Introd. in Hist. Ling. Gr. Proleg.* p. viii. seqq. *Altenburg.* 1778. 8vo.

tain, that wherever they got the first sketch of an alphabet, they improved it very much, not indeed instantly, but gradually, till they brought it to that state in which we now see it, in the twenty-four different characters whereof it is composed*.

To point out completely the analogy which the Greek writers observed in the use of each of those letters, would lead into a very wide field. At present, I propose only to enquire particularly into the nature and principal uses of one of them, I mean the Σίγμα. This, being the sign of a singular sort of sound, has been used, in the structure of the Greek tongue, in a manner different from every other letter; and therefore the Grammarians have generally allotted to it a singular place in their arrangement of the different component members of the Greek alphabet. It will be impossible, however, to treat of the Σίγμα, without making mention of certain circumstances incident to the other consonants.

P A R T I.

THE letter Σίγμα was commonly so called by the inhabitants of Greece, its islands and colonies, except the Dorians, who, as we learn from HERODOTUS, gave it the name of Σάν †. DIONYSIUS of Halicarnassus also mentions this
Doric

* CALLISTRATUS, the Grammarian of Samos, is said to have arranged the Greek alphabet in the order in which we now find it, when EUCLIDES was Archon of Athens. See FOSTER's *Essay on Accent and Quantity*, p. 41. 2d Edit.

† Δαρείεες μὲν τὸ σάν καλέουσι, Ἰωνες δὲ σίγμα. Lib. I.

Doric name *; and ATHENÆUS further observes, that ARISTOPHANES, in his comedy of *The Clouds*, has called those horses who had this letter branded upon them, Σαμφορεί †. It has been by some thought absurd, that the letters, which are the signs of elemental sounds, should be called by any other names than the mere sounds which they denote. It may be said, however, in favour of the Greek names, that they always begin with the letter whose power they denote; and it is a good practical rule in grammar, to say, “That the power of each letter may be known by catching the initial sound of the name ‡.” In speaking particularly of the letters, it is necessary to have a distinct articulate name to give to each of them, because the mere power, especially of the mute consonants, can scarcely be uttered without a vowel; and if the assistance of a vowel be employed in uttering them, then you give them a name somewhat different from their real power, and more likely to lead into error.

WITH respect to the elemental sound of which Σίγμα is the sign, there is no doubt that the Greeks used that letter to express precisely what we denote in English by the letter S in such words as the following, *same, designation, distress*. This we learn from a distinct description, which DIONYSIUS of Halicarnassus has given of the position and effort of the vocal organs in the pronunciation of this letter. “The Σίγμα, says he, is pronounced by an appulse of the tongue to the palate,
“ while

* He mentions it as β called by PINDAR. *De compositione Verborum*, Sect. 14. of which more afterwards.

† ATHENÆUS, p. 467. *Edit. Commelin*. See also ISAACI CASAUB. *Animadverss. in ATHEN.* Lib. X. cap. 21. Σαμφορεί is evidently compounded of Σα and φορεί, μ being always μ before π, β, φ, which will be remarked more particularly afterwards. See ARISTOPHANIS *Nubes*, 122. 1293. *Edit. Brunck. Argentor.* 1783.

‡ LITERÆ cujusque vis intelligitur ex initiali sono nominis. MOOR *Elementa*, L. Gr. p. 2.

“ while the breath rushes through the middle part of it, and
 “ emits a gentle and constricted sibilation about the teeth *.”
 The name itself is evidently derived from *σίζω*, *to hiss*; and
 from the hissing sound of which it is the sign, it has been
 called the serpentine letter. Some have even fancied, that vari-
 ous shapes of the serpent have been copied in the different forms
 it has assumed †. The forms most commonly in use, are two
 for the large or capital letter, thus Σ, C, and three for the small
 one, thus σ, C, c, of which the last is always final, the other two
 initial or intermediate ‡. In order to comprehend more distinctly
 the use of the Σῖγμα, it will here be proper to take a short view
 of the other consonants.

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THE

* Το——σ [ἐκφανέται] τῆς μὲν γλώσσης προσηχνομένης ἄνω πρὸς τοὺς ὀφθαλμοὺς, τὸ δὲ πνεῦμα δὲ μίση αὐτῇ φερομένη καὶ περὶ τοὺς ὀδόντας λεπτὸν καὶ σπινὴν ἐκβάλλοντα τὸ σῖγμα.

CERATINUS's definition is nearly the same: “ Profertur lingua sursum adducta ad pa-
 “ latum, cujus medio spatio spiritus fertur et circa dentes exilem et angustum et quodam-
 “ modo tristem sibilum expellit.” *De Sono Gr. Litt. Libellus*. It ought never to be
 pronounced, as in some English and French words, as if it were the same with Z, or a
 double S. “ Hic quidem certe graviter errant et labuntur præter cæteros Galli, quoties
 “ σῖγμα interjacet duabus vocalibus in una vel diversis dictonibus. Tum enim sonus qui
 “ est in ζῆτα, vel in ZAIN Hebræorum ex eo percipitur: ac perinde pronuntiatur ac si
 “ μῆζα scriberetur. Quod certe vitium dum nonnulli subterfugere ac devitare volunt,
 “ utinam in alterum minime inciderent, nec quasi per geminum SS esset scriptum MUSSA
 “ proferrent.” HEN. STEPH. *Apologet. pro vet. L. Gr. Pron.* In which opinion LAN-
 CELOT agrees. “ Sa prononciation doit estre ferme et entiere, aussibien entre deux
 “ voïelles qu'en tout autre lieu. C'est pourquoi il le faut prononcer dans Χρύσης de mê-
 “ me que dans σὺς ΤΥΑΕ: quoiqu'en François nous prononcions autrement CHRYSÈS que
 “ SES.” *Nouvelle methode pour apprendre facilement la Langue Greque*, p. 16.

† “ SIGMA—merus est sibilus: ideoque ab Hebræis specie quadam serpentis caudam
 “ ad caput retorquentis, et a Græcis, in gyrum sese revolventis, hac videlicet figurâ Σ
 “ vel veluti caput vibrantis, ut σ: denique ut sese sinuantis, pingitur, nempe C. quam fi-
 “ guram Latini imitati.” BEZA *de pronunt. Gr. L.* p. 21. *Edit.* H. STEPH. 1587.

‡ Father MONTFAUCON has given ten different figures of the Σῖγμα, and mentioned
 the different periods when each of them was used. *Palæogr. Gr.* p. 336, 337. “ The
 “ disability of pronouncing this letter is called *Blæfatas*, *Lipping*, whence it is corruptly
 “ sounded like (*tb.*)” WILKINS, p. 369.

THE general difference betwixt vowels and consonants has been very accurately stated by Dr WILKINS, in the following words: " Those letters are called *Vocales*, vowels, in pronouncing of which by the instruments of speech, the breath is freely emitted; and they are therefore styled *Apert*, or open letters. " Those letters are styled *Consonants*, in the pronouncing of which the breath is intercepted by some collision or closure amongst the instruments of speech; and for this reason are they styled *Clausæ Literæ* *."

THE seventeen Greek consonants were divided by the elder grammarians into eight semivowels and nine mutes. " Of the consonants, says THEODORE GAZA, some are semivowels, as ζ, ξ, ψ, λ, μ, ν, ρ, σ, of which ζ, ξ, ψ, are double, and λ, μ, ν, ρ, are immutable and liquid †." According to this arrangement, σ is a semivowel; but in the subdivision of the semivowels into double consonants and liquids, it is tacitly omitted. For this GAZA had the authority of DIONYSIUS the Thracian ‡, and probably of APOLLONIUS DYSCOLUS, whom he very much followed. CONSTANTINE LASCARIS has expressed himself very nearly in the same words §. But EMANUEL CHRYSOLORAS is more explicit. His Grammar is in the form of question and answer. " How are the seventeen consonants divided? Into two sorts, semivowels and mutes. How many are semivowels? Eight, ζ, ξ, ψ, λ, μ, ν, ρ, σ. How are the semivowels divided? Into three sorts, double consonants, immutable consonants, and σ. How many

* *Essay towards a real Character*, &c. p. 363. and 366.

† Τῶν δὲ συμφώνων, τὰ μὲν ἡμίφωνα, οἷον ζ. ξ. ψ. λ. μ. ν. ρ. σ. ὧν διπλὰ μὲν ζ. ξ. ψ. ἀμετέωλα δὲ καὶ ἄγχα λ. μ. ν. ρ. THEOD. GAZÆ *Introductionis Grammaticæ libri IV. fol. 3. Basil. apud VALENT. CURIONEM.* 8vo.

‡ Vide DIONYSII *Thracis Art. Grammat.* Extat in FAB. *Biblioth. Gr.* Vol. VII. p. 26.

§ Vide CONSTANTINI LASCARIS *Grammaticæ Compendium*, p. 2. apud PAULUM MANUTIIUM, ALDI F. *Venet.* 1557. 12mo.

“ny are double? Three, ζ, ξ, ψ. How many are immutable?
 “Four, which are also called liquids, λ, μ, ν, ρ*.” The remaining nine consonants are called mutes by all the grammarians: Of which three, to wit, π, κ, τ, are termed ψιλὰ, *smooth*; three, to wit, φ, χ, θ, are δασέα, *rough*, or *dense*; and three, to wit, β, γ, δ, are μέσα, *intermediate*; in such a manner, that each smooth one has an intermediate and a dense one to correspond to it, which three are said to be of the same rank, because they nearly resemble each other in the manner in which the vocal organs exert themselves in pronouncing them; the first rank π, β, φ, being *labial*, the second κ, γ, χ, being *palatine*, and the third τ, θ, δ, being *dental*, as is well known to every one who has the smallest acquaintance with the principles of the Greek tongue. ARISTOTLE has defined, with his usual acuteness and precision, the difference betwixt a vowel, a semivowel and a mute. “A vowel (says he) is that which, without any allision of the organs, hath an audible sound, as α and ω. A semivowel is that which, with an allision, hath an audible sound, as σ and ρ. A mute is that which, with an allision, hath by itself indeed no audible sound, but is audible in conjunction with the vowels, as γ and δ †.”

I AM sensible that the arrangement of the consonants by the Greek grammarians, has not been approved of by some late writers on the subject of grammar; and there is no doubt but another might be shewn which would seem better adapted to

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the

* Εἰς πόσα διαιρῶνται τὰ δεκάπτη σύμφωνα; εἰς δύο, εἰς ἡμίφωνα καὶ ἄφωνα. πόσα ἡμίφωνα; ὀκτὼ ζ, ξ, ψ, λ, μ, ν, ρ, σ. εἰς πόσα διαιρῶνται τὰ ὀκτὼ ἡμίφωνα; εἰς τρεῖς, εἰς διπλᾶ, εἰς ἀμετάθετα, καὶ εἰς το σίγμα. πόσα διπλᾶ; ἰεῖα, ζ, ξ, ψ. ποσα ἀμετάθετα; τέσσαρες, ἃ καὶ ὑγρὰ λεγοῖται, λ, μ, ν, ρ. EMANUELIS CHRYSOLORAE Gr. Gram. Institutiones. Ven. apud Jo. FARREUM et Fratres. 12mo. Paginis desunt numeri.

† Ἐστὶ δὲ φωνὴν μὲν, ἃνυ προσβολῆς ἔχον φωνὴν ἀκυστήν. οἶον, τὸ α καὶ ω. Ἡμίφωνον δὲ, τὸ μὲν προσβολῆς ἔχον φωνὴν ἀκυστήν οἶον, τὸ σ, καὶ τὸ ρ. Ἄφωνον δὲ, τὸ μετὰ προσβολῆς καθ' αὐτὸ μὲν ὑδρμίαν ἔχον φωνὴν, μετὰ δὲ τῶν ἐχόντων τινὰ φωνὴν γινόμενον ἀκυστός οἶον, τὸ γ καὶ τὸ δ. Περὶ Ποιητ. Κεφ. κ'.

the natural order of the elemental sounds, and the affinity subsisting among certain classes of such sounds. All such as are labial, for instance, might be classed together, whether mutes or semivowels, as $\beta, \mu, \pi, \phi, \psi$; all such as are dental, to wit, ζ, θ, σ ; all such as are lingual, to wit, $\delta, \theta, \lambda, \nu, \tau$; and all such as are palatine, to wit, $\gamma, \kappa, \chi, \xi$. And accordingly this has been done by HULEWICZ, one of the best modern writers on Greek grammar*. But this he has proposed, without rejecting the usual arrangement, which he knew to be so important in examining or explaining the structure of the Greek tongue. For though a division and arrangement of that sort might answer the purpose of a minute anatomical or physiological inquiry concerning the organs of speech, yet as this was not the circumstance chiefly attended to by the Greeks in the progress of their language, though they did not by any means neglect it, we must adhere to that other distribution by the grammarians, if we would wish to comprehend clearly the real use of the Greek letters. There is, for instance, no doubt that μ is a labial consonant, as well as π, β , or ϕ ; and in fact the Greeks in some measure attended to this, as will be afterwards shewn; but the use of μ as a liquid, and its partaking in this respect of the same analogy with λ, ν, ρ , was a connection much more striking, and much more attended to in the practical application of the Greek alphabet†. In the case of the nine mutes, it is of very great consequence to consider how, in.

* See ALEX. GABR. WOJUTYN HULEWICZ, *nobilis Poloni, Institutiones Ling. Græcæ*, p. 14. *Lugd. Bat.* 1746. 4to. M. BEAUZEE, an ingenious French Grammarian, has also proposed a very minute arrangement of the letters, according to an idea of this kind. See *Grammaire Générale, ou Exposition raisonnée des Elémens nécessaires du Langage*, 2 tomes, Paris, 1767. 8vo. See also Bishop WILKINS's *Essay*, &c. p. 357.

† “ Appellantur LIQUIDÆ, — quod post mutam positæ quasi liquecentes ac evanescentes, vim consonantes interdum amittant, neque vocalem præcedentem longam efficiunt, ut aliæ consonantes.” ANTESIGNANUS. *apud* CLENARDUM, p. 3. *Hanoviae*, 1617. 4to.

in the inflections, and in certain other syllabic combinations, each of the letters which compose the different ranks changes its place occasionally with one of its own rank, and not with that of another; and in the case of the liquids, how, if any one of them occur in the nominative of a noun, it must remain unchanged in the oblique cases; and if it occur in the present tense of a verb, it must remain unchanged in the futures; from whence the liquids have also got the name of ἀμετάβολα, *immutable*; likewise, in the case of the double consonants, how each of them is occasionally resolved into the mute of which it is composed, and σῖγμα. All this might be shewn particularly, and at great length. But I return to the Σῖγμα.

IN treating of the Greek characters, some distinguished modern grammarians have not paid due attention to this letter. GRETSER, the Jesuit, in his arrangement of the consonants, has assigned no place to it at all*. He does not even mention it as one of the semivowels, although it be evidently entitled to that distinction. LANCELOT, author of the Port-Royal Grammar, at a loss, it should seem, what to do with it, has classed it, awkwardly enough, with the double consonants. "Although the Σῖγμα, says he, be the only one of its own set, we may nevertheless join it with the double consonants, not only because it forms one of their constituent parts, but also because they all resemble it, by being sibilant in the pronunciation†." Other grammarians, particularly CLENARDUS, ANTESIGNANUS and HULEWICZ, have judged much better in taking the hint from the Greek writers already quoted, especially

* *Institutiones Ling. Gr. Ingoldstadii*, 1605. 12mo.

† "Quoique le σ soit seul de sa bande, nous pouvons néanmoins le joindre avec les doubles, non seulement parce qu'il en fait partie, mais aussi parce que dans leur prononciation elles sont toutes sifflantes comme lui." *Nouvelle Méthode pour apprendre facilement la Langue Greque.* Paris, 1754. 8vo.

especially EMANUEL CHRYSOLORAS, and allowing the Σῖγμα to be a femivowel ; but perceiving that it is neither a liquid, nor a double consonant, nor a mute, they have called it *litera solitaria, et suæ potestatis, vel sui juris* ; the *solitary*, and the *absolute* or *independent* letter ; the letter which possesses a singular and independent power, nowise fettered by that relative analogy to which the other consonants are obliged to submit. That is to say, there has been a singular sound observed to subsist in the Greek language, expressive of a great many varieties in the changes and inflections of words independent of certain other classes of changes and inflections ; and that singular sound has been denoted by the Σῖγμα. For it is certain, that languages were used previous to the invention of letters, though they must have been very rude in that early state. But they would afterwards be much refined by those very letters, the use of which must doubtless have suggested many essential improvements, which would not otherwise have been thought of.

Now, upon what grounds the Σῖγμα is entitled to an exemption or distinction, such as I have mentioned, it may be worth while to examine. The inquiry will tend to shew the great use, and indeed absolute necessity of such a character in the alphabet of this most exquisite of all languages.

Dr SAMUEL CLARKE, one of the most acute and ingenious of all the commentators, has, in a note upon the word πέλασσε, at the beginning of the thirteenth book of the Iliad, mentioned a probable reason, in his opinion, why the ancients held the Σῖγμα to be *suæ potestatis*. “ Πέλασσε, says he, must “ certainly be written with a double σ, because the second syllable of πέλασσε is short. It may, however, (continues he), be “ questioned, whether the more ancient Greeks made use of “ that mode of writing. For when they called σ an arbitrary “ letter, perhaps they meant, that whereas the letters ζ, ξ, ψ, “ are necessarily double, and all the rest of the consonants “ simple, σ alone has this peculiarity, that, in a great many “ places,

“ places, especially the aorists of verbs, it may be pronounced “ either as a simple or a double letter *.” This reason is ingenious; but, upon examining it narrowly, it does not appear to be satisfactory. Indeed Dr CLARKE himself does not seem quite satisfied with it, and offers it only as a conjecture. There is no doubt, however, of what this accomplished scholar has elsewhere † shewn, that the *penult* of the first aorist of such a verb as $\pi\epsilon\lambda\acute{\alpha}\zeta\omega$ is short, but that the poets, as HOMER has frequently done, may make it long, by doubling the σ , or rather by restoring the σ , which had been thrown away in the formation of the first future ‡. Nor is it improbable, that when the poems of HOMER were first committed to writing, the σ was set down single, even when the verse made it requisite to pronounce it double. It happens, however, that this privilege of being occasionally doubled, is not peculiar to the σ . We find, among the poets, other consonants, mutes as well as liquids, frequently in the same situation. Thus,

Ὡς ἔφατ'· ἔδδεισεν δ' ὁ γέρον καὶ ἐπείθετο μύθῳ ||.

And

Τὸν καὶ ὑπέδδεισαν μάκαρες θεοὶ, ἐδὲ τ' ἔδησαν §.

Here:

* *πίλασαι*.] "Ita jam scribendum, necessarium; quia *πίλασαι* secundam corripit. Dubitari tamen potest, utrumne Græci antiquiores isto modo scripserint. Nam quum *σ*, *suæ* *ρο-
teflat* *literam* dixerunt, haud scio an hoc sibi voluerint; literas ζ, ξ, ψ, necessario qui-
dem *duplices* esse; consonantum reliquas omnes, *simplices*; unicam autem *σ*, istiusmodi
esse, ut permixtis in locis, ac *præcipue* in verborum Aoristis, *simplex duplicem* ex æquo
pronunciari possit." *Ad Iliad. v', 1.*

† Vide ad Iliad. α, 140. §, 432.

‡ ACCORDING to the rule, which directs, that, in verbs not liquid, the first future should arise from the present, by inserting a σ before ω , $\pi\epsilon\lambda\acute{\alpha}\zeta\omega$, which is the same with $\pi\epsilon\lambda\acute{\alpha}\sigma\omega$, would have in the first future $\pi\epsilon\lambda\acute{\alpha}\zeta\omega$, or $\pi\epsilon\lambda\alpha\sigma\sigma\omega$. But a special rule directs, that before ω we must, in the future, throw away τ , δ , θ , σ , which makes that tense of $\pi\epsilon\lambda\acute{\alpha}\zeta\omega$ to be $\pi\epsilon\lambda\acute{\alpha}\sigma\omega$ hence the first aorist $\epsilon\pi\epsilon\lambda\acute{\alpha}\sigma\alpha$, to which restore the rejected σ , and it becomes $\epsilon\pi\epsilon\lambda\acute{\alpha}\sigma\sigma\alpha$. Vide MOOR *Element. L. Gr.* p. 128.

|| Iliad. α', 33.

§ Ibid. *a*, 406.

Here the δ is double in ἔδεισεν and ὑπέδεισαν, that ἔδει may be a spondee, which it could not otherwise have been. We find the τ also frequently doubled, as $\tau\tau$, $\tau\tau\iota$ *, instead of σ , $\tau\iota$. In which cases, it is fully as probable, that in the early copies of the poems of HOMER, such words were always written with a simple δ or τ , as that $\pi\epsilon\lambda\alpha\sigma\epsilon$, and others of the same sort, were always written with a simple σ . Sometimes we find ρ , contrary to the rule by which it is said to be always doubled after the syllabic augment, (as $\rho\acute{\iota}\pi\tau\omega$, $\epsilon\rho\rho\acute{\iota}\pi\tau\omicron\nu$), written single by the poets: thus, $\epsilon\rho\rho\acute{\epsilon}\zeta\epsilon$, in the imperfect from $\rho\acute{\epsilon}\zeta\omega$, is written first single, and then double, in the following verses:

Ἄλλος δ' ἄλλω ῥεζε θεῶν αἰετιγενετᾶων †.

Οἷη δ' ἐκ ῥεζε Διὸς κέρε μέγαλοιο ‡.

In the first of these lines, δ' ἄλλω ῥε-- is a dactyl, in which the ω , one of the four diphthongs, is short before the first syllable of ῥεζε, by a well known practice of the poets. Nay, we find, that even in the modern editions of HOMER, the liquid λ occurs written single, when the verse requires it to be pronounced double, which Dr CLARKE himself, with his usual acuteness, has shewn to be the case in the exordium of the Iliad.

Ἡρώων, αὐτὰς δ' ἐλώρια τεύχε κύνεσσιν—

where ἐλώρια must be pronounced as if it were written ἐλλώρια, τὰς δὲ being here a spondee. After all, it must be owned, that σ is much oftener doubled by the poets than any other consonant. Indeed, no consonant but itself admits of being doubled in the penult of the first aorists ||.

THERE

* Iliad. ε', 294.

† Ibid. β', 400.

‡ Iliad. ι', 532. In some editions, ῥεζεζε is written ῥεζεζε in the first aorist, which answers the present purpose as well.

|| In the middle voice it is the antepenult.

THERE are, however, several other grounds on which the claim of this letter to the appellation of *solitary* or *independent*, may be supported.

I. ΣΙΓΜΑ alone of all the consonants employs its power in assisting the mutes to make up the double letters. Thus, any one of the labial mutes π, or β, or φ, assisted by σ, makes ψ· any one of the palatine mutes, κ, or γ, or χ, assisted in the same manner, makes ξ· and any one of the dental mutes, τ, or δ, or θ, with the same help, makes ζ. In the case of ψ and ξ, this is evident from the mode of resolving those double letters in the inflections, especially in the oblique cases of nouns of the imparisyllabic declension. Thus, in the case of ψ, we perceive that *λαίλαψ*, *procella*, is the same with *λαίλαπς*, because its genitive is *λαίλαπος*· that *Ἀραψ*, *Arabs*, is the same with *Ἀραβς*, because its genitive is *Ἀραβος*· that *κατήλιψ*, *scala*, is the same with *κατήλιφς*, because its genitive is *κατήλιφος*· and in the case of ξ, we perceive that *κόραξ*, *corvus*, is the same with *κόραυς*, because its genitive is *κόρακος*· that *φλόξ*, *flamma*, is the same with *φλόγς*, because its genitive is *φλόγος*· that *ὄνυξ*, *ungula*, is the same with *ὄνυχς*, because its genitive is *ὄνυχος*. But the same analogy in the case of ζ is not so easily traced; and indeed the critics and grammarians, who have written in Greek, do not even assert that ζ is equivalent to δς, but to σδ*. Their reason seems to have been, that they never observed ζ resolved into two simple consonants, except in the Doric manner, as *μελίσδω*, instead of *μελίζω*, *modulor*; *ὄσδω*, instead of *ὄζω*, *oleo*. The learned HULEWICZ even denies that ζ is a double letter; “ because, “ (says he) it never is equivalent to two consonants, like ξ and “ ψ· for if ζ were a double consonant, it would occur in the “ termination of Greek words, as well as ξ and ψ, which it
VOL. II. R “ never

* Vide DIONYS. Hal. περὶ συνθ. ὀνομ. ιδ'. DIONYS. Thracem apud FABRICIUM in *Biblioth. Gr.* Vol. VII. p. 28. THEOD. GAZAE *Grammat.* fol. 24. These are followed by CLENARDUS, &c.

“ never does *.” But, in answer to this, it may be said, that the argument against ζ being a double consonant, because it never terminates a word, cannot be admitted, as it is no where asserted, that to be a final letter is absolutely necessary to the existence of a double consonant. But, granting this to be the case, ζ may in fact be said, as well as ξ and ψ, to be a final letter, if the following circumstances be properly attended to. It is observed by HULEWICZ himself, as well as other grammarians, that the dental mutes τ, δ, θ, are thrown away before σ. This happens evidently in the formation of the first futures of verbs: thus, *τύπτω, verbero*, not *τύπτσω* in the future, but *τύπσω*, which is written *τύψω*; *ἄδω, cano*, not *ἄδσω*, or *ἄζω*, but *ἄσω*; *πλήθω, impleo*, not *πλήθσω* nor *πλήζω*, but *πλήσω*. One reason for this seems to be, that if τς, or δς, or θς, had been permitted to remain in the first futures of verbs, they must have produced ζ, and this would have confounded the termination of those futures with that of the present tenses of a great many verbs in ζω, and thus have given rise to a great ambiguity in the case of present and future tenses; an inconvenience which the Greeks carefully avoided, and in the present instance the more willingly got rid of, because the throwing away of τ, δ, θ, before σ, gratified an antipathy, which the Grecian ear, during the progress and refinement of their language, seems to have conceived against the combination of those consonants †; for it is evident, from the analogy of certain genitives which end in τος, δος and θος, that, in the early times of the Greek language, a great many nouns terminated in τς, δς and θς, which is the same with terminating in ζ; thus, *λείβητς*, or *λείβηζ*, by rejecting the τ before ς, becomes

* *Institut. Gram.* p. 13.

† ANOTHER reason is, that, in many verbs, it would produce too great a concurrence of consonants. See this illustrated above, p. 127. note †.

comes λέβης, *lebes*, but τ remains before ο in the genitive, λέβητος· λάμπαδς, or λάμπαζ, by rejecting the δ before ς, becomes λάμπας, *lampas*, in the genitive λάμπαδος· ὀρνιδς, or ὀρνιζ, by rejecting θ before ς, becomes ὀρνις, *avis*, in the genitive ὀρνιδος *. Farther, it may be inferred, that ζ is equivalent at least to δς, from what happens in the formation of the second future of such verbs as ὀζω. For as τύπτω hath in the second future τυπῶ, by throwing out the τ, which is the latter of the two consonants, the former being the characteristic of the tense; so ὀζω (ὀδσω) hath ὀδῶ, by throwing out the σ, which is the latter of the two component consonants in ζ, the δ being properly the characteristic of the tense. In the same manner, φράζω (φράδσω) hath φράδῶ, and ἔζω (ἔδσω) hath ἐδῶ. But that ζ was considered by the Greek writers as a double consonant, may be clearly evinced from this, that, like the other two, ξ and ψ, it obliges a vowel immediately preceding it, though naturally short, to be long by position, as is well known to all who have the smallest acquaintance with Greek prosody. It may be concluded then, that ζ is not only a double consonant †, but is equivalent either to τς, or δς, or ϑς, though the general practice of the Greek writers was to reject τ, δ, ϑ immediately before σ, or to set down σ in most cases where the general analogy requires ζ, and this, it should seem, in order to produce a sound more pleasing to the

R. 2 ear.

* SOMETIMES τ is thrown out betwixt κ and ς, after which the κς coming together must make ξ; thus, ἀιακς, ἀιακς, ἀιαξ, *rex*, Gen. ἀιακτος, where the ξ is resolved into κς, and the τ is restored. See a most ingenious Dissertation, ascribed to the late learned Mr JER. MARKLAND, entitled, *De Græcorum Quintâ Declinatione Imparisyllabicâ, et inde formata Latinorum Tertiâ, Quæstio Grammatica*. Extat cum Editione alterâ EURIPIDIS Dramatis *Supplicium Mulierum*, quam Londini excudebat doctus typographus GUL. BOWYER, nuper defunctus, ejusque discipulus J. NICHOLS. 1775.

† THE other arguments adduced by HULEWICZ. to prove that ζ is not a double consonant, do not seem to have any weight. *Vid. Institut. Gram. Gr. ubi supra.*

ear*. Σῖγμα, therefore, not only lends its assistance to the dental mutes, in order to form ζ, but even frequently occupies the place of ζ, the component mute being rejected.

II. ΣΙΓΜΑ is the only consonant whose power is employed in the formation of the dative plural of the imparisyllabic declension; and this is done by interposing it immediately before ι of the dative singular: as, ῥήτωρ, *orator*, Dat. Sing. ῥήτορι, Dat. Plur. ῥήτορσι. So κόραξ (κόραξ), *corvus*, D. S. κόρακι, D. P. κόρακσι, which is κόραξι· φλόξ (φλόγς), *flamma*, D. S. φλόγι, D. P. φλόγσι, which is φλόξι· βήξ (βήχς), *tussis*, D. S. βήχι, D. P. βήχσι, which is βήξι. So also ὤψ (ὥπς), *oculus*, D. S. ὥπι, D. P. ὥπσι, which is ὥπι· Ἀραψ ("Αραβς), *Arabs*, D. S. Ἀραβι, D. P. Ἀραβσι, which is Ἀραψι· κατήλιψ (κατήλιψς), *scala*, D. S. κατήλιφι, D. P. κατήλιφσι, which is κατήλιψι. Also, δαῖς (δαίτς), *epulum*, D. S. δαιτί, D. P. not δαισι, nor δαιζι, but δαισι, because τ, δ, θ, are thrown away before σ. λάμπας (λάμπαδς), *lucerna*, D. S. λάμπαδι, D. P. not λάμπαδσι, nor λάμπαζι, but λάμπασι. ὄρνις (ὄρνιδς), D. S. ὄρνιδι, D. P. not ὄρνιδσι, nor ὄρνιζι, but ὄρνισι†.

III. IN

* It deserves to be remarked, that one of the liquids, viz. ν, is also thrown away before σ of the nominative, and restored again in the genitive. Thus, μέλας, *niger*, for μέλας, has, in the genitive, μέλανος. From some nominatives, both ν and τ are thrown away, and restored in the genitive: thus, γίγας for γίγαντς, Gen. γίγαντος* and they are again thrown away before σ in the dative plural, which is not γίγαντσι, but γίγασσι. And when, in the presents of verbs, ν and δ occur together, they are both thrown away before σω of the future: thus, κυλίνδω, *voluto*, κυλίσσω, evidently for the sake of a more pleasing sound. *Vid. Moor Elementa L. Gr.* p. 128.

With respect to what HULEWICZ asserts about the final σ, in nouns of the third declension being changed into δ, θ, ν, τ, in the genitive, as, ἔρις, *lis*, Gen. ἑριδος* ὄρνις, *avis*, Gen. ὀρνιδος* μέλας, *niger*, Gen. μέλανος* χάρις, *gratia*, Gen. χάριτος* this arises from his not having observed, with Mr MARKLAND, that the full nominatives of those words are, ἔριδς, ὀρνιδς, - ἑλανς, χάριτς* and that σ is not changed into the above mentioned consonants, but that these having been thrown away in the nominative, *euphoniae causa*, are restored in the genitive, where that reason no longer takes place. *See above*, p. 130.

† In the dative plural, ν is also thrown out, as ποιμήν, *pastor*, D. S. ποιμένι, D. P. ποιμήσι. Other changes are made in this case in certain nouns. *euphoniae gratiā*, but σ is always inserted.

III. IN the formation of the Greek verb, where a system of the most beautiful kind may be traced, the singular or peculiar power of Σιγμα is very conspicuous.

1. IT is *always* the characteristic of the first future, in verbs that are not liquid, a station which it maintains without a rival. Thus, in pure verbs, *τίω, βοοο, τίσω, λύω, λύω, τίμαιω, βοοο, τιμήσω, φίλειω, ἀμο, φιλήσω, πλήρω, impleo, πληρώσω* in mute verbs, *πλέκω, πλικο, πλέκω, which is πλέξω, φεύγω, fugio, φεύγω, which is φεύξω, βρέχω, irrigo, βρέχσω, which is βρέξω* also, *βλέπω, video, βλέπω, which is βλέψω, τρίβω, tero, τρίβω, which is τρίψω, γράφω, scribo, γράφω, which is γράψω* and so also in verbs ending in *τω, δω and θω*, in which the *τ, δ, θ*, are rejected before *σω* of the future, as has been already observed and exemplified*.

2. IT is *never* the proper characteristic letter of the present tense, and therefore in that respect also it is singular. There are indeed a great many verbs which end in *ζω* and as it has been said that *ζ* is composed of *δς*, &c. it may be supposed that *σ* is here the characteristic of the present. But as in some verbs, such as *τύπτω* and *ρίπτω*, the former of the two consonants, to wit *π*, is reckoned the characteristic; so in such verbs as *φράζω* and *νομίζω*, *δ* perhaps is the characteristic, as if they were *φράδσω* and *νομίδσω* †. With respect to those verbs which end in

* P. 130. It is to be remarked, that in pure and mute verbs, the *σ*, which is the characteristic of the first future active, is also that of the first aorist active, the first future, and first aorist middle; which it is needless to exemplify, as it is quite familiar, even to young scholars.

† IN the Doric dialect, they are *φράδω* and *νομίδω*. Σ, however, is certainly the characteristic of their first future, where *τ, δ, θ*, are always thrown away. In this case, the propriety of throwing out the *δ* is apparent; for, if it were retained, *φράζω* would have in the first future *φράζω*, which is the same with *φράδσω* and *νομίζω* would have *νομίζω*, which is the same with *νομίδσω*, where it is necessary also to throw away the *σ* which came from the present tense, on account of the *σ* which was assumed by the formation as the characteristic of the future, and therefore the futures actually are *φράσω* and *νομίσω*. See this hinted at above, p. 127. note †. See likewise, Moor *Elementa Ling. Gr.* p. 129.

in $\sigma\sigma\omega$ in the present, in which a σ must be supposed to be the characteristic, this termination is plainly incident to a particular dialect, and those futures in $\xi\omega$, which are said to arise from them, are actually derived from obsolete presents: thus, $\pi\rho\acute{\alpha}\xi\omega$, the future, which is said to come from $\pi\rho\acute{\alpha}\sigma\sigma\omega$, is evidently formed from the obsolete $\pi\rho\acute{\alpha}\gamma\omega$, which may be learned from the second future, which is $\pi\rho\alpha\gamma\tilde{\omega}$. Indeed, $\pi\rho\acute{\alpha}\sigma\sigma\omega$, and other verbs of that termination, cannot have a first future regularly formed, as σ , which is improperly adopted as the characteristic of the present, cannot also be the characteristic of the future in the same verbs. I may add, that the later Attics rejected that termination in $\sigma\sigma\omega$, and substituted $\tau\tau\omega$, saying $\pi\rho\acute{\alpha}\tau\tau\omega$, instead of $\pi\rho\acute{\alpha}\sigma\sigma\omega$ *. I must not omit observing too, that a few verbs occur which terminate in $\psi\omega$ and $\xi\omega$, in the present, in which σ may be supposed the characteristic of that tense. But these seem to be futures substituted in place of certain obsolete presents from which they are derived, and whose meaning they have assumed. I know not that there are any more of them than the following, $\epsilon\psi\omega$, *coquo*; $\omicron\delta\alpha\xi\omega$, *mordeo*; $\acute{\alpha}\lambda\epsilon\xi\omega$, *opitutor*; $\alpha\tilde{\upsilon}\xi\omega$, *augeo*. At any rate, so few exceptions, and those too of such a questionable shape, can have no effect against a general rule. The consequence, however, is, that such verbs, by having a σ in their present, must be defective; for there is no proper way of distinguishing their first future, the σ already being employed as the characteristic of the present.

3. ΣΙΓΜΑ *never* is the characteristic of liquid verbs, the liquid of the present always remaining in the future, and some other change being employed to mark this last tense, such as the shortening of the penult, if it be long, and the circumflexion of the final $\tilde{\omega}$ †. The reason is, the analogy of the Greek tongue does not permit a liquid to precede σ , except, sometimes in the Doric dialect, as, $\omicron\rho\omega$, *ex-*
cito,

* Vide LENNÉP in *Analogiam L. Gr.* p. 55, 56, &c.

† See MOOR *Elementa L. Gr.* p. 128.

cito, ὄρω* or for some special cause, as in the case of the preposition ἐν in composition, for example ἐνσπείρω, *infero*, as will be shewn more particularly afterwards*.

IV. THE singularity and independent nature of the σ is also very striking, when we take a view of the state in which the liquid ν is found, when it precedes the different letters of the alphabet †. This may be successfully exemplified in the case of words compounded with the prepositions ἐν and σὺν where we may remark one scheme of analogy for the vowels, one for each rank of the mutes, (which includes also the double consonants, as these all begin with a mute,) and one for all of the liquids; but the solitary and absolute Σίγμα possesses a sort of analogy peculiar to itself, different from all the rest, though no less regular and beautiful.

1. EN and σὺν, in composition, remain before the vowels without any change; as, EN-Αλλάσσω, *immuto*; ΣΥΝ-Οίκεω, *una habito*, &c.

2. BEFORE the first rank of the mutes, ν is changed into μ. Thus,

EM-	Πίπτω,	<i>incido.</i>	ΣΥΜ-	Πείθω,	<i>una persuadeo.</i>
	Βάλλω,	<i>injicio.</i>		Βαίνω,	<i>concredior.</i>
	Φόρτω,	<i>importo.</i>		Φρονέω,	<i>consentio.</i>

The reason is, that μ, being a labial liquid, coalesces better than ν with the labial mutes π, β, φ, which may be observed in every such union in the language ‡.

3. BEFORE

* See below p. 137.

† THE liquids are called immutable for the reason formerly given; but their immutability applies chiefly to their situation in the inflections of nouns and verbs; for ν is mutable in different parts of the analogy here remarked.

‡ PARTICULARLY in those new presents in ανω, which are formed from the second future of other presents by changing ω into ανω, and inserting ν immediately after the vowel in the antepenult: thus, λείπω, λιπῶ, λιπάω, λιπάνω, which is λιμπάνω λήβω, λαβῶ, λαβάνω, λαμβάνω, which is λαμβάνω. The same thing happens before ψ, which is compounded of any labial mute and σ, thus, ΕΜ-Ψύχω, *refrigero*. See p. 120. note †.

3. BEFORE the *second* rank of the mutes, *ν* is changed into *γ*. Thus,

ΕΓ-	Κλείω,	<i>include.</i>	ΣΥΓ-	Καλέω,	<i>convoco.</i>
	Γράφω,	<i>inscribo.</i>		Γελάω,	<i>simul rideo.</i>
	Χρίω,	<i>inungo.</i>		Χέω,	<i>confundo.</i>

The reason is, there being no palatine liquid, *γ*, the intermediate palatine mute, coalesces better than *ν* with the mutes of its own order; and this is a combination of very frequent occurrence in the Greek language*; the sound of the *ν* being at the same time retained and incorporated in the pronunciation with that of *γ*, though the former is thrown out in writing, to avoid the concurrence of three, and sometimes of four consonants.

4. BEFORE the *third* rank of the mutes, *ν* remains unchangeable; thus, ΕΝ-Τείνω, *intendo*, ΣΥΝ-Ταράσσω, *commoveo*, &c. The reason is, *ν* being a dental liquid easily coalesces with the dental mutes, without any change.

5. BEFORE a liquid, *ν* passes into a liquid of the same kind with that which it precedes; thus,

ΕΛ-Δάμπω,	<i>illuceo.</i>	ΣΥΛ-Λέγω,	<i>colligo.</i>
ΕΜ-Μιγνύμι,	<i>immisceo.</i>	ΣΥΜ-Μάεπτω,	<i>corripio.</i>
ΕΝ-Ναίω,	<i>inhabito.</i>	ΣΥΝ-Νοέω,	<i>mecum reputo.</i>
ΕΡ-Ριγώω,	<i>inalgesco.</i>	ΣΥΡ-Ρέω,	<i>confluo.</i>

All this evidently was done *euphoniæ causâ*. But it is to be observed, that before verbs beginning with *ρ*, the preposition *ἐν* seldom passes into *ἐρ*, because, in that case, certain persons of the present tense of the compound verb would be confounded with certain persons of the imperfect tense of the simple verb; for in verbs beginning with *ρ*, the *ρ* is doubled after the syllabic augment; wherefore the euphony was generally here sacrificed, in order to

* Thus, from φαίω, *ostendo*, we have in the perfect, not *πίφανκα*, but *πίφαγκα*. And in the new presents in *αυ*, formed from a second future, as already mentioned in the preceding note; *ἐρίγω*, *ἐρυγῶ*, *ἐρυγάνω*, *ἐρυγάνω*, which is *ἐρυγγάνω** *λήχω*, *λαχῶ*, *λαχάνω*, *λαγχάνω*, which is *λαγγχάνω*. The same thing happens before *ξ*, which is compounded of any palatine mute and *σ*: thus, ΕΓ-Ξέω, *insculpo*.

to obtain a greater advantage, ἐνράπτω, *insuo*, for instance, being preferred to ἐρράπτω*.

6. IN the case of the solitary Σῖγμα, ν before σ, if a vowel follows the σ, becomes another σ, thus, ΣΥΣ-Σιτέω, *una cibum capio*. If a mute follows the σ, then, in the case of συν, the ν is struck out; but in the case of ἐν, it remains: thus,

σπ	{	ΣΠάω, <i>contrabo.</i>	{	ΣΠείρω, <i>infero.</i>	
σβ ΣΥ-		[No example †.]		EN-	[No example †.]
σφ		ΣΦαττω, <i>simul jugulo.</i>		ΣΦραγίζω, <i>signum imprimo.</i>	

σκ	{	ΣΚάπτω, <i>simul fodio.</i>	{	ΣΚήπτω, <i>ingruo.</i>	
σγ ΣΥ-		[No example †.]		EN-	[No example †.]
σχ		ΣΧηματίζω, <i>conformo.</i>		ΣΧολάζω, <i>immoror.</i>	

στ	{	ΣΤρατεύω, <i>simul milito.</i>	{	ΣΤρέφω, <i>intorqueo.</i>	
σδ ΣΥ-		Ζάω , <i>una vivo.</i>		EN-	Ζέομαι , <i>inferveo.</i>
σθ		[No example ‡.]			[No example §.]

VOL. II.

S

The

* THE inconvenience which was thus prevented by ἐν remaining unchanged, may be perceived by declining the present tense of the compound verb, and the imperfect of the simple verb; thus,

COMPOUND VERB: PRESENT TENSE.

S. ἐρράπτω,	ἐρράπτεις,	ἐρράπτει,
D. ΕΡΡΑΠΤΕΤΟΝ,	ΕΡΡΑΠΤΕΤΟΝ,	ΕΡΡΑΠΤΕΤΟΝ,
P. ΕΡΡΑΠΤΟΜΕΝ,	ΕΡΡΑΠΤΕΤΕ,	ἐρράπτεσσι.

SIMPLE VERB: IMPERFECT TENSE.

S. ἐρράπτω,	ἐρράπτες,	ἐρράπτει,
D. ΕΡΡΑΠΤΕΤΟΝ,	ΕΡΡΑΠΤΕΤΟΝ,	ἐρράπτεται,
P. ΕΡΡΑΠΤΟΜΕΝ,	ΕΡΡΑΠΤΕΤΕ,	ἐρράπτον.

† THIS cannot be exemplified, because there is no Greek word which begins with σβ, except σβέννυμι, *extinguo*, with its verbals.

‡ THERE is no Greek word which begins with σγ.

§ FOR ζ, which we shewed above to be equivalent to δς, is also, at least in the Doric dialect, equivalent to σδ.

§ THERE is no primitive Greek word which begins with σθ, except σθίω, *valeo*.

The reason why ν remains in the case of $\epsilon\nu$, is, that if ν were omitted, as in the case of $\sigma\nu\nu$, certain persons of the present of the compound verb would be confounded with certain persons of the imperfect tense of the simple verb, as in the case of $\epsilon\nu$ becoming $\epsilon\epsilon$ before ϵ , which has been already mentioned *.

V. *Lastly*, THE peculiar nature of $\Sigma\gamma\mu\alpha$, and that which seems to have suggested its various functions in the structure of the Greek tongue, arises from this, that it is the only letter which is sibilant or hissing in the whole Greek alphabet. For ζ , which by some is considered as a sibilant letter, is no farther so than the two other double consonants ξ and ψ and whatever sibilantion is observed in their sound, they plainly derive from σ , which is half of their composition.

IN what manner then the improvers of the Greek language availed themselves of this singular letter, I have now endeavoured to show. From the various uses to which it has been applied, some have considered it as a servile letter; and from its hissing, and, as they thought, disagreeable sound, some of the ancient writers, notwithstanding its great use in their language, conceived a violent dislike at it. But this, with several other particulars relative to the same letter, I propose to consider in a second part of this Essay.

IN the mean time, if the authority of names be deemed of any use in justifying inquiries of this nature, I may ask with QUINCTILIAN, “An ideo minor est M. TULLIUS orator, quod
“idem artis hujus diligentissimus fuit, et in filio (ut in epistolis apparet) recte loquendi usquequaque asper quoque exactor?
“Aut vim C. CÆSARIS fregerunt editi de analogiâ libri? Aut
“ideo minus MESSALA nitidus, quia quosdam totos libellos non
“de verbis modo singulis, sed etiam literis dedit †?”

IF

* THIS will appear evident, by declining the present tense of a compound verb, with the ν thrown out; as $\iota\sigma\tau\epsilon\iota\omega$, &c. and the imperfect tense of the simple verb, as $\iota\sigma\tau\epsilon\iota\sigma\sigma\epsilon\iota$, &c.

† *Institut. Orat. Lib. I. Cap. 7.* “Vilescit tibi hic sermo. Itane? Scilicet MURETO
“et LIPSIO indignum decurrere Grammaticum hoc æquor, quod tot olim Senatores
“imò.

If a farther apology still be requisite for a long discourse upon a subject seemingly so frivolous as a single letter, I might deny that the subject is frivolous. Nothing, it might be said, is frivolous, which has for its object an investigation into the most minute causes of the cultivation of that faculty, which, next to our intellectual powers, is the most important the human species enjoys; without which indeed our intellectual powers themselves would, in a great measure, be destitute of the means of improvement, but with the elegant and correct use of which, elegance and correctness in science must ever go hand in hand. I may add, that it is an exercise surely of no illiberal sort, to explore, and to produce to view, those marks of minute attention which the most accomplished people in the world bestowed upon the constituent elements of their language, and which contributed to render that language of all others the noblest in every respect, and to all those who attain to a knowledge of it, the object of enthusiastic admiration.

P A R T II.

ALTHOUGH the letter Σίγμα be of such essential use in the inflections of the Greek language, as I have endeavoured to explain, yet when it happens, either in prose or in poetry, to be frequently introduced without necessity, the re-

S 2 peated

“imò addo, Imperatores. MESSALA orator, è clarissimâ CORVORUM gente, non librum
 “integrum De unicâ literâ S composuit? et cum laude quidem nominis sui, adeò sine
 “fraude. CLAUDIUS Imperator, quantâ curâ, et pænè dicam ambitione, tres novas
 “litteras invexit. iisque Romanam linguam auxit? non aliâ, quam si totidem regnis im-
 “perii fines. Jam CÆSAR ille JULIUS De Analogiâ, id est de infimis Grammaticorum
 “ineptiis, binos libros conscripsit: et triumphales illas epulas variare et interlinguere
 “non erubuit scholicâ istâ dape.” LIPSIVS de rectâ pronunc. Ling. Lat.

peated fibilation thereby occasioned is undoubtedly very disagreeable to the ear. Of this, a noted passage in the *Medea* of EURIPIDES, which has been severely censured by some critics, is a sufficient proof.

Ἔσωσα σ', ὡς ἴσασιν Ἑλλήνων ὅσοι
 Ταυτὸν συνεισέβησαν Ἀργῶν σκάφος *.

The poet, however, had not attended to this circumstance, otherwise he would have avoided such an offensive tautology. CICERO, from inadvertence of a similar sort, has begun his *Topica* with the following sentence: "Majores nos res scribere ingressos, C. TREBATI, et iis libris, quos brevi tempore fatis multos edidimus, digniores, e cursu ipso revocavit voluntas tua." Several such passages might be produced from the best authors, both Greek and Latin, if it were worth while to collect them.

IT is remarkable, that in the English tongue, where almost no inflection takes place, and consequently where the S has no peculiar duty to discharge, that letter is of more frequent occurrence than in any other language, and occasions, especially in the ears of foreigners, a constant and disagreeable hissing †. Such a language would have been considered as harsh and barbarous in an extreme degree, by those ancient authors who were
 offended

* Verse 477.

† "S (says JOHNSON) has in English the same hissing sound as in other languages, and unhappily prevails in so many of our words, that it produces in the ear of a foreigner a continued fibilation." *Dist. Letter S.* ADDISON too had observed, "That a change has happened in our language, by the abbreviation of several words that are terminated in *eth*, by substituting an S in the room of the last syllable, as in *drowns*, *walks*, *arrives*, and innumerable other words, which, in the pronunciation of our forefathers, were *drowneith*, *walketh*, *arriveth*. This (adds he) hath wonderfully multiplied a letter which was before too frequent in the English tongue, and added to that hissing in our language, which is taken so much notice of by foreigners." *Speculator*, No. 135.

offended even with a moderate use of Σῖγμα in the Greek. DIONYSIUS of Halicarnassus, in particular, has said, that “ the Σῖγμα is harsh and unpleasant, and when unnecessarily repeated, exceedingly offensive ; for its hissing seems to be connected with what is wild and irrational, rather than with the voice of rational beings. Wherefore (continues he) some ancient authors used it but seldom, and with caution, and others composed whole odes without this letter *.”

To condemn, however, the use of this letter on all occasions, either because its sound resembles the hissing of a serpent, or perhaps because the sound of hissing has been an usual mode of expressing dislike in different ages and nations of the world, would be a fastidious and hypercritical method of judging. HERODOTUS, the sweetest of all prose writers, furnishes a variety of such periods as the following : Κροκοδείλους δὲ Ἴωνες ἀνόμασαν, εἰκάζοντες αὐτῶν τὰ ἔειδα τοῖσι παρὰ σφίσι γινομένοισι κροκοδείλοισι τοῖσι ἐν τῇσι αἵμασιῇσι †. From this we may infer, that the Ionic Greeks were not very much disgusted even with a frequent repetition of the Σῖγμα. But such a passage, not only on account of the frequent occurrence of Σῖγμα, but also of ἴωτα, would have been intolerable to an Attic ear, which seems to have had a particular aversion to the repeated use of the letter in question, and induced that refined people to prefer the double ττ to the double σσ in a great many of their words ; as when they said θάλαττα instead of θάλασσα, πρᾶττω instead of πρᾶσσω, and even σρεῖττω instead of σρείσσω, *to hiss*. The propriety of such a change, however, seems to have been the subject of dispute among some of the ancient writers, and gave occasion to a *jeu d'esprit* of LUCIAN, which has descended to our times,

* "Αχαρι δὲ καὶ ἀγῆδες τὸ σ, καὶ ἐν πλειονάσει, σφιδρα λυπῶν. Σηριώδης γὰρ καὶ ἀλόγος μᾶλλον ἢ λογικὴς ἐφάπτεσθαι δοκεῖ φωνῆς ὁ σφριγμός· τῶν γὰρ παλαιῶν σπανίως ἐχρᾶντο τινες αὐτῷ καὶ πεφυλαγμένως· ἔτι δὲ οἱ ἀσίγμως ῥέδας ὅλας ἐποίουν· Περὶ συνθ. Ὀνοματ. Edit. REISKIUS, Vol. V. p. 80.

times, under the title of Δίκη Φωνήεντων *The judgment of the Vowels*; where that exquisite author, with his usual talent for ludicrous composition, has introduced the letter Σῖγμα arraigning the letter Ταῦ before the tribunal of the seven Vowels, and calling out loudly for justice against the encroachments made upon him by this atrocious delinquent. It is scarcely possible to render the performance intelligible to a mere English reader, as the ridicule chiefly arises from the solemnity with which an unimportant substitution of certain Greek letters in the place of others, is treated. But it may be translated in such a manner as to amuse this learned audience, and serve perhaps as some sort of atonement for the trespass committed against their patience, in the former part of a dry grammatical discussion. The humour of the piece is heightened, by its being a very successful and well supported imitation of an ancient pleading.

LUCIAN'S *Judgment of the Vowels.*

“ IN the Archonship of ARISTARCHUS of Phalerum *, on the
 “ 7th of November †, the letter Σῖγμα commenced a profe-
 “ cution against the letter Ταῦ, at the bar of the seven
 “ Vowels, for violent distraining of goods, alleging that he
 “ was plundered of all those words usually pronounced with
 “ a double Ταῦ.

“ YE

* THE learned CORSINI, merely upon the authority of this passage of LUCIAN, has inserted in his *Fasti Attici*, the name of ARISTARCHUS Phalereus, as *Archon Eponymus* at Athens, in the 1st year of the CCXXII. Olympiad, and of the Christian æra, 109. It may be supposed, however, that, in a ludicrous composition of this sort, LUCIAN would not mind an adherence to the truth of chronology, but might pitch upon an Archon on this occasion called ARISTARCHUS, in allusion to the famous grammarian of that name who was born in Samothracia, and flourished at Alexandria about the CLVI. Olympiad; and who was so eminent in his art, that the name ARISTARCHUS became synonymous with the word *Critic*. See CORSINI *Fasti Attici*, Tom. II. p. 104. and Tom. IV. p. 165.

† SCALIGER and others suppose Πυανψιών to correspond to the month of October. I have preferred the opinion of PETAU and CORSINI, who make it to agree with November.

On

“ YE VOWELS, before whose tribunal I stand, as long as
 “ the injuries I received from this Ταῦ here were but of a tri-
 “ vial nature, whilst he abused my property, and encroached
 “ upon me where he had no just right or title, I bore the loss
 “ without repining; and out of the deference which you know
 “ I observe both to you and the other syllables, I lent a deaf
 “ ear to certain insinuations which were circulated to his dis-
 “ credit. But since he proceeds to such a pitch of avarice and
 “ folly, as to be constantly adding more heinous acts of vio-
 “ lence to those which, with a reluctant silence, I used to suffer,
 “ I am forced to arraign him before you, who are well ac-
 “ quainted with the disposition of us both. And I am under
 “ no small apprehension, on account of this expulsion to which
 “ I am exposed; for while he is continually adding something
 “ more violent to what he has already perpetrated, he will soon
 “ thrust me completely out of my own province, so that by be-
 “ having thus tamely, I shall run the risk of being no longer
 “ accounted a *letter*, and all of us shall have some reason to be
 “ alarmed*.

“ It is therefore expedient, that not only you who at pre-
 “ sent sit in judgment, but likewise the other Letters, should
 “ be upon your guard against this daring attempt. For if any
 “ one who has amind shall be permitted to quit the post af-
 “ signed

On the 7th of Πυανέσιων, were celebrated at Athens the festivals called Πυανέσια and Ὀρχοφύγια. See CORSINI *Fastis Attici*, Vol. I. p. 63. and Vol. II. p. 383. Also, POTTER'S *Archæol.* Vol. I. p. 418. & 423.

* In the Greek, the last member of this sentence is, ἐν ἴσῳ δὲ κᾶσθαι τῷ φόβῳ· to which BOURDELOTIUS proposes to add, τὰ λοιπὰ γράμματα· which he found on the margin of one MS. and the rest of the letters be in the same alarming situation. Instead of τῷ φόβῳ, the celebrated HEMSTERHUIS seems disposed to read τῷ [i. e. τῇ] ψίφῳ, and to render the sentence as follows: *Ita ut parum absit, quin, si quietus injuriam ultra feram, e numero literarum expungar, neque alio sim loco, quam sonus aliquis, vel, fibilus.* I have no doubt that the phrase, as it is in the printed books, came from the pen of LUCIAN, ἐν ἴσῳ δὲ κᾶσθαι τῷ φόβῳ, i. e. δὲ τι τῷ φόβῳ κᾶσθαι ἡμῖν ἐν ἴσῳ, and all of us have some reason to be alarmed. This meaning is confirmed by what immediately follows.

“ signed to him, and violently to intrude himself into that of
 “ another, and this too by *your* connivance, without whose aid
 “ nothing is written to any purpose, I cannot see how the fe-
 “ veral ranks will maintain their just rights, according to the
 “ original arrangement. But I trust that neither you will ar-
 “ rive at such a pitch of negligence and sloth as to permit the
 “ perpetration of injustice, nor, though *you* should decline all
 “ participation in this struggle, must I, who am the sufferer,
 “ abandon my plea.

“ WOULD to heaven! the audacity of certain other letters had
 “ received a check the instant they began to violate the law,
 “ and then Λάμβδα would not at this day have been at daggers-
 “ drawing with Πῶ, disputing whether a *pumice-stone* should be
 “ written κισσῆρις or κισσῆλις, or a *headach* should be κεφαλαλγία
 “ or κεφαλαργία nor would Γάμμα have been perpetually
 “ wrangling, and even frequently upon the point of coming
 “ to blows, with Κάππα, in the fuller’s shop, insisting that *the*
 “ *flocks of wool shorn off by the fuller*, should be γναφάλα and not
 “ κνάφαλα and the same Γάμμα would have no longer con-
 “ tended with Λάμβδα, by taking away from him, and indeed
 “ totally robbing him of, the word *hardly*, calling it μόγισ in-
 “ stead of μόλις and the rest of the letters would have aban-
 “ doned every attempt to introduce an illicit confusion. For it
 “ is fair that each should abide by his appointed station; as
 “ every transgression of the bounds prescribed marks the cha-
 “ racter of a subverter of justice.

“ WHOEVER at first established these laws for us, whether it
 “ was CADMUS the islander *, or PALAMEDES the son of NAU-
 “ PLIUS,—(some ascribe this important charge to SIMONIDES)
 “ —not only determined who should be first and who second
 “ in

* See above, p. 118. note †. The famous CADMUS, son of AGENOR, is here called ὁ νησιώτης, from his connection with Tyre, according to ancient authors originally built in an Island, which ALEXANDER is said afterwards to have joined to the Continent. See the notes of DU SOUL and HEMSTERHUIS, in the 4to Edit. of LUCIAN’s Works. Tom. I. p. 87. Amst. 1743.

“ in that order wherein the seats of precedence are fixed, but
 “ also fully understood the qualities and powers which belong
 “ to each of us. And on you, ye Judges, he hath conferred
 “ the larger portion of honour, inasmuch as you are capable
 “ of expressing a sound by yourselves; on the semivowels, the
 “ next share to yours, because they require a small degree of
 “ your assistance, in order to be distinctly heard; and he hath
 “ allotted the least of all to some who, by themselves, possess
 “ no sort of sound whatsoever*. Wherefore, it is the province
 “ of you Vowels to be the guardians of these laws.

“ BUT this Ταῦ, (for I have not a more opprobrious appel-
 “ lation for him than his own name†) who, unless, by Jupiter!
 “ two of yourselves, I mean”Αλφα and Υ, excellent both, and
 “ seemly to behold, had come propitious to his aid, would not
 “ even have been heard,—this very culprit dares to injure me
 “ in a more atrocious manner than ever any other of the letters,
 “ by expelling me from my native nouns and verbs, at the
 “ same time chasing ‡ me away from conjunctions and prepo-
 “ sitions, insomuch that I am no longer able to endure his ex-
 “ cessive rapacity. But it is now time to state whence, and
 “ from what circumstances, these outrages originated.

“ I ONCE was sojourning at Cybelum, an agreeable enough
 “ little town, a colony, as is reported, of Athenians, and took
 “ along with me the best of my neighbours, the robust Πῶ.
 “ I lodged at the house of a certain comic poet, whose name
 “ was LYSIMACHUS, by extraction evidently a Boeotian, but
 “ who was ambitious of passing for a native of the very centre
 “ of Attica. While I remained in the house of this landlord,
 “ I detected the avarice of this same Ταῦ. As long as, by de-
 “ priving me of my congenial friends, he seized only on a few
 “ VOL. II. of

* See ARISTOTLE's definition of a Vowel, a Semivowel and a Mute, p. 123.

† See below, p. 149.

‡ I have adopted the reading proposed by HEMSTERHUIS, viz. ἀπλάσσει and ἐκδιώκει.

“ of them, so as, for instance, to call *forty* τετταράκοντα instead
 “ of τεσσαράκοντα, I imagined it to be a common practice among
 “ the letters who were there educated together. And even
 “ while he claimed a right to force *to day* into his train by the
 “ name of τήμερον instead of σήμερον, and used the same freedom
 “ with other words of that kind, as if they had been his own
 “ property, I tolerated what I heard with some degree of pa-
 “ tience, and was not very violently provoked upon the occa-
 “ sion. But when, after beginning in this manner, he had the
 “ impudence to metamorphose the word signifying *steel* from
 “ κασσίτερον into καττίτερον, and to call *cobler's leather* κάττυμα
 “ instead of κάσσυμα, and *pitch* πίττα in place of πίσσα; and,
 “ in short, having divested himself of all sense of shame, to
 “ insult the name of *Queen*, by pronouncing that βασίλιντα
 “ which ought to have been βασίλισσα, I got into a most furi-
 “ ous paroxysm of rage, being apprehensive that some one, in
 “ process of time, might venture to say τύκα instead of σύκα,
 “ and so not leave me so much as a single *fig*.—I beseech
 “ you, in the name of Jove! to bear with this just indigna-
 “ tion, when you reflect that my spirit is so much depressed,
 “ and that I have none who are ready to help me; for when
 “ the question is about depriving me of words that have been
 “ my wonted and familiar companions, surely no trivial and
 “ vulgar objects are at stake. Having torn my prattling κίσσα,
 “ my favourite *magpie*, as it were out of my bosom, he calls it
 “ his κίττα, and, in defiance of the command of ARISTAR-
 “ CHUS, he hath seized on my *ringdove*, which he calls φάττα,
 “ on my *ducks*, styling them νήτται, and my *oufels*, to which he
 “ gives the odious name of κοττύφοι. He hath borne off whole
 “ hives of my *bees*, calling them μελίτται instead of μελίσσαι.
 “ Nay, having made an incursion into the Attic territory, he
 “ hath even carried away, in the most outrageous manner, the
 “ region of bees, mount *Hymettus* itself, and that too before
 “ your own eyes and those of the other syllables. But why
 “ do

“ do I mention such circumstances as these? He has banished
 “ me entirely out of *Thessaly*, to which he insists upon giving
 “ the name of *Thettaly*, and he has claimed an exclusive right
 “ to the very *sea*, which he calls *θάλυττα* instead of *θάλασσα*.
 “ Nor does he even abstain from the *beets* in my garden, inso-
 “ much that he has not, I may say, left me a single *πάσσαλος*,
 “ or *little pole*, which I can call my own. But you yourselves
 “ can bear me witness what a patient *character* I am; for I
 “ never so much as found fault with ζ, when he stole my pre-
 “ cious *σμεράγδος* *, or *emerald*, from me, and thrust me out of
 “ the city of *Smyrna*; nor with ξ, when he violated every sti-
 “ pulation †, and even has THUCYDIDES the historian as the
 “ abettor of his guilt. As to my next neighbour *Ῥῶ*, it was
 “ but an act of humanity in me to forgive *him*, when, in the
 “ *delirium* of a disease, he planted my *myrtles* in his own garden,
 “ as if they had been called *μυρρίναι*, and not *μυρσίναι*, and,
 “ under the pressure of a deep melancholy, struck me a blow
 “ on the cheek. Such is the patient natural temper with which
 “ I am endowed.

“ BUT the violent disposition of this Ταῦ will be still more
 “ apparent, when we reflect, that he has also injured, not only
 “ Δέλτα, Θῆτα and Ζῆτα, but almost every one of the other
 “ letters. Call in the plaintiffs. Hear, O ye Judges, what
 “ Δέλτα has to say.—Δ. He hath bereaved me of my faculty of
 “ *perseverance*, requiring, in the face of all law, that it shall be
 “ called *ἐντελέχεια* instead of *ἐνδελέχεια*.—Listen, I beseech you
 “ to the wailing of Θῆτα, who is tearing his hair in anguish for
 “ the loss of his *gourd*, which has been changed from *κολυκύνθη*
 “ into *κολυκύντη*; and to Ζῆτα, complaining that he no longer
 “ hears the *music of the pipe* nor the *sound of the trumpet*, *συρίζειν*

T 2

“ and

* WHICH is sometimes written *ζμεράγδος*, as *Σμίρνα* is written *Ζμύρνα*. See the annotation of HEMSTERHUISIUS.

† *σύνηκην*,—which THUCYDIDES writes *ξύνηκην*, and so in many other words, using ξ for σ, as is well known.

“ and σαλπίζειν being now supplanted by συρίττειν and σαλπύττειν
 “ and that he is not allowed even to *grumble*, the proper word
 “ γρύζειν being now no more. Who could have patience to en-
 “ dure such indignities? or what punishment is adequate to
 “ the demerits of this most execrable Ταῦ?

“ BUT, in short, he is not only injurious to his kindred tribe
 “ of letters, but has already begun to encroach upon the hu-
 “ man race, in such a manner that he permits them not to
 “ make a proper use of their tongues. *Apropos* of tongues,
 “ which this mention of human affairs has introduced, it
 “ brings to mind how the miscreant has usurped my province
 “ here too, by metamorphosing γλῶσσα, a tongue, into γλῶττα.
 “ O thou villanous Ταῦ! thou very bane of all tongues!—
 “ But to return from this digression to the defence of men,
 “ whom he has so grossly injured. He attempts to torture their
 “ voice, and bind it with chains. When one person beholds
 “ a beautiful object, and wishes to style it κάλον, *fair*, up comes
 “ this Ταῦ, and most impudently obliges him to call it τάλον;
 “ such is the violence of his claim to be at the head of every
 “ thing! When another is speaking of a *vine-branch* by the
 “ appellation of κλήμα, he himself being τλήμων, a *wretch*,
 “ makes the poor word wretched too, by calling it τλήμα.
 “ Nor are his injuries confined to vulgar men; he even forms
 “ a plot against that tremendous Monarch, to whom the earth
 “ and the sea, in a supernatural manner, are reported to have
 “ yielded*; and instead of giving him his proper name Κῦρος,
 “ CYRUS, he speaks of him by the appellation of Τῦρος, as if
 “ he were a *cheese*.

“ SUCH then are the ways in which he injures men in their
 “ speech. But how does he still more materially injure them?

“ They

* LUCIAN seems here to allude to the magnificence of the oriental style. XENOPHON, in the *Anabasis*, relates, that CYRUS the younger, with his army, passed the Euphrates on foot, which had never been forded in that manner before, and adds—ἰδοκεὶ θεοὶ εἶναι, καὶ σαφῶς ὑποχωρῆσαι τὸν ποταμὸν Κῦρος ὡς βασιλεύσονται. Lib. I. See the annotation of HEMSTEADT.

“ They lament and deplore their hard fate, and often execrate
 “ CADMUS for introducing this Ταῦ among the number of the
 “ letters. For they say that tyrants, taking the hint from the
 “ appearance, and imitating the form, of this letter, did fa-
 “ bricate gibbets to hang men upon; and hence this most
 “ mischievous contrivance obtained its odious name*. For all
 “ these crimes, how many deaths do you suppose this Ταῦ de-
 “ serves? For my own part, I reckon the only punishment
 “ adequate to his guilt would be to hang him upon a machine
 “ of his own shape; for it was owing to him that there was ever
 “ such a thing in the world as the figure or the name of a
 “ gallows.”

THUS far LUCIAN; and it must be owned that the ludicrous
 manner was the most proper that could be employed in treating
 such a subject. LIPSIUS, in his Dialogue *de rectâ pronunciatione*
Latinae linguæ, has observed, “ That many attack the reputation
 “ of the letter S, and even form a design against its life.”—
famam ejus multi petunt, imo vitam.—And he adds an enumera-
 tion of those enemies. “ PINDAR (says he) reproaches it, and
 “ calls it κίβδηλον, *spurious*, and, out of hatred to it, is said to
 “ have composed verses without its assistance. DIONYSIUS the
 “ rhetorician, in exalting the Πῶ, undervalues this letter, and
 “ brands it with the vile epithet of Σηγιώδη, *savage*. All the
 “ Attics detest it, and generally have substituted Ταῦ in its
 “ room. Latin authors seem to join in the conspiracy; and,
 “ among men of rank, MESSALA says it is not even a *letter*,
 “ but only a *hiss*. Among teachers, QUINCTILIAN pronounces
 “ it to be a rough letter, and harsh in the combination of
 “ words. Nay, even the ancient writers rejected it, in imita-
 “ tion

* “ VERISSIMA vocis σταυρός origination: ταῦ, ταυηρός, hoc est in modum ταῦ effor-
 “ matus: et per contractionem ταυρός et præposito sigma ut fieri solet, σταυρός.” ME-
 NAGIUS.

"tion of the Attics; and their method was, to use *meritare* and *pultare* instead of *merfare* and *pulfare*, just as ENNIUS used *adgrettus fari* instead of *aggressus fari*. The poets also have taken a side; and, in their verse, this letter, when a consonant follows, is commonly expunged. Thus,—*vitâ illâ dignu' locoque*. And—*omnibu' princeps*: And in the Plays of PLAUTUS and TERENCE, examples frequently occur."

AGAINST all this hostility which has been declared against the S, LIPSIUS undertakes its defence. The passage is curious; but being too long for a quotation, I refer to the work itself. The elegant MURETUS is a speaker in the Dialogue, and on him LIPSIUS devolves the task of vindicating his favourite letter; but, like other strenuous advocates, he appears to carry his zeal for his client too far*.

THERE

* I SHALL translate some excerpts from it in this note. In answer to PINDAR's charge, MURETUS insists, "That Σίγμα has a genuine sound, and every other mark of a genuine letter." And with respect to the epithet of *ῥηιδης*, given to it by the Halicarnassian, if the meaning be, that Σ denotes a sound similar to the hissing of serpents, this he thinks a very strange objection. "Why then (says he) don't you despise the letter R, because it is expressive of the noise of dogs? M, because that of oxen? B, because that of sheep? For dogs *snarl*, oxen *low*, or utter a noise which in Greek is *μυρδαι*, and in Latin *mugire*, and sheep *bleat*. But since you call this hissing of serpents detestable, tell me, what shall you think of winds, of trees, of men? You will not deny that they *whisper*, and that most agreeably.—The ancient inventors of names, as if nature had been their guide, denoted the most delightful of all objects by this letter. Look up to the heaven, there you behold the *sun*, the *stars*. Look down to the earth, among the things that are *sweet*, you find *sesame* and *sugar*; among the charms of love, *whispers* and *kisses*; and among the joys of life, *sleep*, *safety*, *soundness*." And a little after he adds, "The Attics, you say, despised it. Why should I be surprised that the most fastidious of mortals did so? But the Lacedæmonians and Thebans were of a different opinion. At this very day, the robust inhabitants of Germany delight in this strong sibilating sound, which (let not my LIPSIUS be offended) is avoided by you, the delicate inhabitants of the Netherlands. You are in the wrong. But I do not point out your error, because LUCIAN has already pleaded and discussed the cause before the tribunal of the Vowels." The speaker next proceeds to answer the objections of MESSALA and QUINCTILIAN, and then shews that the ancient writers made very frequent use of this letter, insomuch that their insertion or substitution of it seemed, in his opinion, to favour of affectation; and, after producing a great many instances of this, and accusing those poets

THERE seems, however, to be no good reason either for applauding or condemning the sound of this letter in the extreme. Passages have been already quoted from EURIPIDES and CICERO, which, if read with attention, must convince every one, that its frequent recurrence is disagreeable to the ear, though that circumstance seems to have escaped the notice of the authors themselves in composing those sentences. But MILTON has, with manifest design, availed himself of the discordant sound produced by such a repetition, and that with powerful effect, in the following verses, where SATAN, when described as having arrived at Pandæmonium, and in a boasting manner related his success against Man, is received by his infernal audience with a general hiss.

So

poets of ignorance who despise this letter, he puts the question, "Have not I now said enough, LIPSIVS, about the fondness and respect which the ancients had for this letter?—Yes, quite enough."

THIS Dialogue betwixt LIPSIVS and MURETUS, is dedicated to the renowned Sir PHILIP SIDNEY. The scene is laid on the Quirinal, in a garden belonging to the splendid HIPPOLYTUS of ESTE, the patron of MURETUS. LIPSIVS represents himself as a young man on his travels at Rome, possessing an ardent desire of knowledge. Having paid a visit at the apartments occupied by MURETUS in the house of his patron, he was shewed into the garden, where he found that accomplished scholar so deeply engaged in reading, as for some time to pay no attention to the approach of the stranger. The book he had in his hand happened to be a work of LIPSIVS himself, entitled *Varia*, which had been lately published at Antwerp. A pleasing description of this interview is given by LIPSIVS in the commencement of the Dialogue, "*Cubiculum ejus cum pulsassem*," &c. They afterwards enter upon the proper subject of the piece, in which MURETUS is represented as the principal speaker. But the style, in point of elegance, is far inferior to what MURETUS would have really made use of. The work indeed is confessedly the composition of LIPSIVS, whose Latinity, though he was one of the ablest critics of the sixteenth century, has with justice been censured. His merit was such, however, that even his style procured a numerous tribe of imitators. But no modern writer of Latin has surpassed the elegance of MURETUS. His orations in particular, in point of ease and fluency of expression, may perhaps even vie with those of CICERO. It must give every scholar pleasure to hear, that the celebrated RUHNKENIUS of Leyden, is at present engaged in preparing for the press a new and complete edition of the works of MURETUS. "Il faut (says BAYLE) bien aimer les mauvais modeles quand on est capable de préférer le style de LIPSE à celui de PAUL MANUCE, ou à celui de MURET; un style qui va par sauts, et par bonds, herissé de pointes et d'ellipses, à un style bien lié et coulant, et qui developpe toute la pensée." *Dict. Artic. LIPSE, Not. [L.]*

So having said, awhile he stood expecting
 Their universal shout and high applause
 To fill his ear: when contrary he hears
 On all sides from innumerable tongues
 A dismal universal hiss, the sound
 Of public scorn. —————

He would have spoke,
 But hiss for hiss returned with forked tongue
 To forked tongue: for now were all transform'd
 Alike, to serpents all, as accessories
 To his bold riot: dreadful was the din
 Of hissing through the hall; thick swarming now
 With complicated monsters, head and tail
 Scorpion and asp, and amphiboena dire,
 Ceraustes horn'd, hydrus and elops drear
 And dipsas*.

ON the other hand, it is certain, that a judicious introduction of this letter produces, on many occasions, a very pleasing effect; such as may be perceived from the two concluding words of the following verses of the same poet. Our first parents are the subject.

—————He on his side
 Leaning half-raised, with looks of cordial love
 Hung over her enamoured; and beheld
 Beauty, which whether waking or asleep
 Shot forth peculiar graces; then with voice
 Mild, as when Zephyrus on Flora breathes,
 Her hand, soft touching, whisper'd thus †.

THEOCRITUS, in the very beginning of his first Idyllium, represents THYRSIS, a shepherd, addressing a goatherd in the following manner: "Goatherd, this pine, which is beside
 " the

* Par. Lost, Book X.

† Ibid. Book V.

“ the fountain, melodiously utters its whispering strains with
 “ inexpressible sweetness : thou too playest exquisitely on the
 “ pipe :” —

Ἄδῃ τι τὸ ψιθύρισμα καὶ αἱ πίτυς, αἰπόλε, τήνα,
 Ἄ ποτὶ ταῖς παγαῖσι μελίσσεται· ἄδῃ δὲ καὶ τὸ
 Συρίσδες· —

With respect to the whispering or gentle rustling produced by the pines, the Greek Scholiast remarks, “ That the pines whisper
 “ when they are gently fanned, the breeze being broken by
 “ the closeness of the leaves *.” He has likewise observed,
 “ That the word ψιθύρισμα is contrived on purpose, from the
 “ peculiarity of its sound, to imitate the sound which it ex-
 “ presses †.” I may add, that the Doric words μελίσσεται and
 συρίσδες, instead of μελίζεται and συρίζεις, by bringing σῖγμα be-
 fore δέλτα, considerably augment, in this instance, the sweet-
 ness of the sound.

* Ψιθυρίζουσι αἱ πίτυς, ὅταν ῥηπισθῶσι, τῇ στενότητι τῶν φύλλων σχιζομένης τῆς πνοῆς.

† Ὀνομασπιοῦται δὲ ἡ λέξις παρὰ τὴν τῷ ἤχῳ ιδιότητα, κατὰ μίμησιν τῆς φωνῆς.
 HOMER abounds in instances of Ὀνομασποῖα, as is well known.

V. ACCOUNT *of the* GERMAN THEATRE. By HENRY
MACKENZIE, Esq; F. R. S. EDIN.

[*Read by the Author, April 21. 1788.*]

NO country perhaps affords a more interesting literary speculation at present than *Germany*. For researches in science and philosophy, for laborious investigations into the principles of public polity and law, she had long been conspicuous; but, till very lately, she made scarce any pretension to fame in the other departments of literature, which usually precede those more abstract and laborious pursuits I have just mentioned. Even in history, her writers were few; but of poetry and *belles lettres*, scarce a trace was to be found; and of the very little of either, which the authors of that country produced, the language in which they conveyed it, was a foreign one. But of late, Germany begins to exert herself in the more elegant walks of literature, with an uncommon degree of ardor; and in her literary aspect, she presents herself to our observation in a singular point of view, that of a country arrived at maturity, along with the neighbouring nations, in the arts and sciences, in the pleasures and refinements of manners and society, and yet only in its infancy with regard to writings of taste and imagination. These, however, from this very circumstance, she pursues with an enthusiasm, which no other situation could perhaps have produced; the enthusiasm which novelty inspires, and which the severity incident to a more cultivated and critical state of literature does not restrain. Since the time of HALLER (who, by an extraordinary combination of talents, united the
deepest

deepest abstraction of science with the ease and pleasantry of the lightest poetry) and of GELLERT, the LA FONTAINE of Germany, that country has thrown into the circle of literature a greater variety of productions in poetry and belles lettres than any other nation of Europe. While other countries have been applying themselves chiefly to moral, physical and geographical enquiries, Germany, remounting as it were to the sources of ancient inspiration, has given to the world works of that creative sort, which are seldom produced in those later times, when fancy and imagination give place to the sober certainties of science and philosophy. Among those works of imagination, it is sufficient to mention several epic poems, one of which at least, the *Messiah* of *Klopstock*, is of the most acknowledged and universal reputation.

THE language of Germany, however, has not yet attained, as those who know it inform us, that perfection and regularity necessary to stamp the highest value on the productions composed in it. Its currency, for the same reason, is far from extensive; and therefore the original German works are scarce read at all beyond the circle of the empire. French and English translators, particularly the former, have made up to strangers the loss which this would otherwise have occasioned; and few books of any merit now appear in Germany, that are not republished in the French language by the booksellers of Paris.

OF these, one of the most remarkable, and, from its nature, one of the most interesting, is the *Theatre Allemande*, or a Collection of the most approved theatrical performances of Germany, translated into French by Messrs FRIEDEL and DE BONNEVILLE, which is rivalled by another collection of the same kind, though not hitherto so extensive, by Messrs JUNKER and LIEBAULT; both translations, as far as one may judge from intrinsic evidence, are executed with fidelity and ability.

As the drama of every country marks more strongly than any other of its productions, the features, both of its genius and of its manners, I thought I should afford a not unacceptable piece of information to this Society, by giving an account of those publications, accompanied, as it naturally must be, with some remarks on dramatic composition in general, arising from the particular observations excited by the works in question. Neither that account, nor those remarks, will pretend to completeness or regularity. Written amidst a variety of other occupations, with but little leisure either of time or of mind, I only mean them as presenting to the Members of this Society a sketch of something that merits the further enquiry of the industrious, and which, as an amusement, will well repay the time which the unemployed may be induced to bestow on it.

It appears by a preliminary discourse, prefixed to Mr FRIEDEL's translation, somewhat contradicted, but without much effect, by the preface of Mr JUNKER, that it is only at a very late period that the theatre of Germany has arrived at any degree of perfection. In the year 1727, GOTTSCHED, professor of Philosophy in the University of Leipzig, undertook a reformation of the German stage, till that time sunk in a state of barbarism. But he gave only translations of French plays, with one or two miserable originals of his own, long since forgotten. It was not till between the years 1740 and 1750, that any performance of merit appeared, or that actors of eminence (with very few exceptions) seem to have existed to perform them. About that period, the celebrated ECKHOF, the ROSCIUS of Germany, began his theatrical career, in which he continued to delight his countrymen till his death, which happened in 1778, a year remarkable in the annals of the stage, since it deprived the world of three of its greatest actors, LE KAIN, GARRICK and ECKHOF.

BESIDES the low state of polite literature in Germany before that period, of which I have taken notice above, the small extent

tent of each individual state must necessarily have obstructed the progress of theatrical exhibition. The establishment of a good theatre is too expensive for the limited revenues of the smaller potentates, among whom great part of Germany is divided. At *Vienna*, *Berlin* and *Dresden*, there were theatres supported at very considerable expence; but these, I believe, were destined for the opera. This would indeed naturally be the case, where the entertainment was meant for the Court. Dramas that rouse the passions, that shake the soul, afford pleasure only to the body of the people; the great and the fashionable relish much more those species of entertainment which gratify the finer senses, or amuse the lighter fancy of the indolent and the voluptuous. Music and dancing, or musical dramas which include both, are always their favourite amusements.

THE progress of the German stage must have also been considerably impeded by the circumstance of the language being so different in different parts of the empire; and in some of them so degraded in the *patois* of the country, as of course to make French the common language of the better sort of people.

IN the year 1747, LESSING, whom the Germans regard as the chief of their dramatic authors, produced his first comedy at Leipzig; and from this time downwards, a variety of authors of genius contributed to form and to establish the theatrical taste of Germany. Their attempts, however, seem still to have been obstructed by the particular situation of the country. No capital, like Paris and London, united or rewarded their efforts. The King of Prussia, from whom one would have looked for literary patronage, had always a prepossession for French, and a contempt for German literature. We find him therefore bestowing high honours on LE KAIN, who acted occasionally on a French theatre established at Berlin, but never interesting himself about the establishment of a German stage. It is pretty remarkable, that the muses of the empire found
protection

protection and support chiefly from persons engaged in commerce, the first theatres of any eminence being built by the merchants of Leipzig and Hamburg. After the conclusion of the last war, however, the theatre appears to have received considerable encouragement at Vienna, Berlin, Mannheim and Dresden.

ABOUT this period, the taste for sentimental and pathetic writing began to be wonderfully prevalent in Germany. The works of STERNE, and several other English authors of the same class, were read with the greatest avidity. I remember to have been told of a club or society, instituted at some town in Germany, whose name was taken from the *snuff-box*, which forms a striking incident in the celebrated story of the monk in the *Sentimental Journey*. The Poems of WIELAND, GESNER, WEISSE, &c. are full of the most refined sentiment and sensibility; and the celebrated *Sorrows of WERTER* of Goethe carries those qualities to that enthusiastic height, which has so much captivated the young and the romantic of every country it has reached *. This prevalence of highly refined sentiment seems commonly the attendant of newly-introduced literature, when letters are the property of a few secluded men, and have not yet allied themselves to the employments or the feelings of society. The same thing took place at the revival of letters in Europe after the long night of the middle ages. The Platonic love of the ancient romance, and of the poetical dialogue of the *Provençals*, was the produce of the same high-wrought and metaphysical sentiment, which is the natural result of fancy and feeling, untutored by a knowledge of the world, or the intercourse of ordinary life.

WE are not therefore to wonder, if, amidst what we might be apt to term refinement in point of sentiment and expression,

we

* Soon after the publication of that little work, it became a badge of fashion among the young men of Germany, to wear as a uniform the dress which WERTER is described as having on in one of his interviews with CHARLOTTE.

we should find in those German dramas, a disregard for the regularities and the decorum of the stage, which is considered as marking a very rude state of the dramatic art. Such disregard, in effect, some of those dramas exhibit in a remarkable degree. The scene is fullied with murder, and disfigured with madness, as often as that of the ancient English tragedy. And in one of the plays of this collection, in point of tenderness and passion, a performance of very high merit, AGNES BERNAU, the heroine of the piece, is executed on the stage in a manner as repugnant to the delicacy or dignity of theatrical situation as can well be imagined, to wit, by being drowned; and one of the executioners is exhibited pushing her down into the water when she attempts to save herself.

THIS disregard of rule, and this licence of the scene, are attended with many unfavourable, and yet perhaps with some fortunate effects. The rules of sound and liberal criticism certainly produce, in the hands of great ability and genius, the most exquisite and delightful performances. Yet there is a certain reach of genius, which they may restrain from exertions that might sometimes accomplish very valuable productions. There are moments of peculiar warmth of imagination and felicity of language, which, in the course of a work where fancy is indulged beyond the bounds of rigid critical rule, a writer may experience above the level of his ordinary powers. Without an attention to the critical regulations of the drama, VOLTAIRE would not have written such admirable tragedies; but, from the restraints which the necessity of that attention imposes on the theatre of France, that theatre is loaded with those thousand insipid plays which every year at Paris are exhibited and forgotten. The monotony of the modern French drama may fairly enough be imputed to that nicety and fastidiousness of a French audience, which will not suffer any irregularity, though sanctioned by nature, or dignified by genius. I mean not by this to plead for any indulgence to a licence their stage has lately

lately assumed in point of moral *bienfiance*, which is equally unfavourable to excellence of composition and to decency of manners. The same remark might be extended to our stage, were it not now sunk to such a state of degradation as hardly to be worthy of notice.

THE collection of the German theatre by JUNKER, contains, besides *Sara Sampson*, which is common to both publications, three tragedies, six comedies, a *drame* and a pastoral. That of FRIEDEL consists of twelve volumes, containing twenty-seven dramatic pieces, of which thirteen are tragedies, nine are called comedies, and five *dramas*, a species of performance for which we have not yet got in English a very definite term. It holds a sort of middle place between tragedy and comedy, borrowing from the first its passions and sentiments, from the last the rank of its persons, and the fortunate nature of its conclusion.

THIS sort of drama was for some time extremely popular in France, and was thence adopted into the theatres of England and Germany, but particularly into the latter, where it seems to have been peculiarly adapted to that turn for high-wrought sensibility, which I have before mentioned as having become a sort of national taste in that country. Indeed, most of the comedies of these volumes might be classed under this denomination.

THERE are three historical plays, one of which, of the highest popularity in Germany, is *Goetz de Berliching*, founded on the history, or rather indeed detailing the history, of a chief of that name, in the war of the peasants in the time of the emperor MAXIMILIAN. This play goes beyond the utmost licence of our SHAKESPEARE, in its change of scene and multiplicity of incident. Yet this was written as late as the year 1773.

THE principal authors of these collections are LESSING, GOETHE and BRANDES. The two first are sufficiently known; the last, BRANDES, is the director of a company of German comedians ;

medians ; and if we may judge from his performances in this collection, one of the ablest of the German dramatists, though he seems not to have attained in his own country so much consideration as I should be disposed to allow him.

IN JUNKER's collection is a comedy of GELLERT's, which gives a very favourable idea of his talents for comic character and dialogue, called *The Lottery Ticket*.

WEISSE, a name of high dramatic reputation in his own country, is the author of two tragedies in these volumes, one of which, *Romeo and Juliet*, is an extremely popular performance in Germany. It is an imitation of SHAKESPEARE's *Romeo and Juliet*, with the plot much compressed and connected ; but, in the swell of its language, and the extravagance of its allusions, it goes rather beyond the original. *Juliet*, however, is a better and more interesting female character than is generally found in this collection.

THERE is one performance, which, as it is of a singular kind, I may dismiss with a particular notice here, by a writer whom Germany places by the side of HOMER and MILTON, KLOPSTOCK, the author of the *Messiah*. This is the *Death of Adam*, written in a dramatic form, though, as the author himself informs us, not meant for representation. The subject indeed seems to exclude it from the stage ; but the situations, though not of a pleasing, are of a highly interesting kind, and the conceptions and language are marked with that force and sublimity which his countrymen so enthusiastically admire in KLOPSTOCK. The angel of death is introduced as a person in the drama, announcing to ADAM his approaching fate. The appearance of this majestic and terrible being is prepared in a manner uncommonly awful and sublime. ADAM and his son SETH are on the scene. " The terrors of the ALMIGHTY (says " the father of mankind) are upon me. My eyes lose you, " my son. What darkly gleaming light rolls before me ? " Feel'st thou the shaking of this rock ? Dost thou hear the
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“ trembling of that hill? Upon that hill behold him! Seest
 “ thou, my son, the angel of terror?” “ ’Tis night around
 “ me, (replies SETH) but I hear the noise of sounding steps!”
 The sublimity of this terror, which is conveyed to the ear
 while invisible to sight, has been felt in the same manner, and
 is expressed in nearly the same words, by a poet of our own
 country, who, in that passage at least, has touched the lyre
 with the true energy of a bard. “ Hark, (exclaims the Druid
 in *Caractacus*)

“ Hark! heard you not yon footstep dread .

“ That shook the earth with thundering tread,

“ ——’Twas Death!”—

It will be no disparagement to either of the modern poets, if they
 shall be thought to have borrowed the idea from the *Oedipus*
Coloneus of SOPHOCLES.

THE angel is visible to ADAM, and announces his approaching
 dissolution with the simplicity and solemnity of his function.
 The signs he gives are the sun descending behind the grove
 of cedars, and the return of the angel, whose steps shall again
 shake the earth; “ Thine eye shall be dim, and thou shalt not
 “ see me—but thou shalt hear the rock burst with the noise of
 “ thunder—thou shalt hear, and die!” The reader is thus pre-
 pared for the awful event, and the imagination watches, from
 scene to scene, the sinking of the sun and the shaking of the
 earth, with that anxious expectation, those *minute-terrors* (if
 the expression may be allowed me), which, of all circumstances,
 give the strongest emotion to the mind. I take this short no-
 tice of the detail of the particular drama in question, though
 not quite in its proper place here, because it stands without the
 pale of theatrical criticism, and because it is the production of
 a writer who is but little known in this country, though his ge-
 nius is revered, even to idolatry, in his own.

I NOW return to give some general account of the dramatic collections before us. Most of the pieces of which they consist are plays of situation rather than of character. In the comedies, it is not the *miser*, the *misanthrope*, the *hypocrite*, that is represented, but a father offended by the *misalliance* of his child, a husband hurt by the ridiculous extravagance of his wife. The tragedies, in like manner, do not exhibit a personification of ambition, revenge or jealousy, but a son outraged by his father, a baron offended by his prince, a prince tyrannised over by his love. I am inclined to think the characteristic drama the most pleasing, and generally the most excellent. The character of the leading person introduced, marks the events and the situations in which it is placed, in such a way as strongly to impress the imagination and the memory of the reader, and colours, as it were, that particular province of mind which the author means to delineate, with a precision and a force which is not found in scenes where the situation only acts on the general feelings of our nature. This kind of drama, however, is not so commonly found in later periods of society, both because those later periods do not so frequently produce peculiar and strongly distinguished characters, as because such characters have been already seized by the earliest dramatic writers, who only leave to their successors the power of tracing them through their subdivisions and modes, of painting the nicer shades by which the same great features of the human mind are discriminated in different persons. I think it may be remarked as a defect in the collections before us, that the dramas do not always place those features in a strong and steady light. The characters are not always perfectly or uniformly supported, and the persons are sometimes exhibited acting from motives not quite consistent with the general plan of their character, nor appearing of sufficient force to produce their actions. This may perhaps be imputed to that extreme refinement of feeling, which I have before remarked to be particularly predominant

in these pieces. Objects seen through the medium (a medium too rather fluctuating and uncertain) in which the persons of the drama are placed, strike them with a force which the reader does not always readily allow, and become motives to a conduct of which he does not always perceive the necessity or the use. Characters such as those of SHAKESPEARE, which act from the original native feelings of the soul, are immediately acknowledged by the corresponding feelings of the audience. It is of no consequence in this particular, that they are sometimes ideal beings, placed in a world of fancy, different from the real. They have still a set of feelings, consonant to that sphere in which they are placed, and to those characters with which the poet has invested them. But in the metaphysical refinements of sentiment, the same thing does not take place. There the feelings are created, not the characters; and we have no leading radical idea to which we can refer them, to which we can discover that intimate relation, which it is the great excellence of the poet to preserve, and the great pleasure of the reader or the spectator to trace.

THE plots of these dramas are generally simple, but rather diffuse; a fault to which the freedom from critical restraints of time and place, claimed by the authors of several of them, is apt to lead. They are frequently too easily anticipated in their conclusion; and, in the conduct, they do not produce many of those striking theatrical situations, which, even to the most enlightened spectators, are highly pleasing, but which seem absolutely essential to the entertainment of an ordinary audience. In perusing some of these plays which have obtained the most universal reputation in Germany, one is led to give the audiences of that country credit for a high degree of refinement, when we are told of the unbounded applause they bestow on those pieces, the merit of which does by no means lie in striking incidents, or in what are called *coups de theatre*, but consists chiefly in a minute developement of feeling and sensibility,

bility ; a refinement and eloquence of sentiment which one would imagine the bulk of the people could neither understand nor admire. Perhaps, however, an audience may admire what it does not perfectly understand, if a few sentimentalists of high name do but shew it what it ought to admire. In sentiment, as in religion, there is a mystical sort of enthusiasm, which warms the fancy without submitting itself to the understanding ; in sentiment, as in religion, enthusiasm is easily communicated. High refinements, which go far beyond real life, catch with a rapidity of infection. They are the creed of a sect, which is always propagated with more ardor and bigotry than the rational belief of a community.

IN the conduct of the fable, some of their authors, as I mentioned before, do not confine themselves to any observance of the unities of time and place, but assume a licence of transporting their audience, even in the midst of what they call (though by what rule I know not) an *act*, into different provinces and distant periods. In the reading, this offends but little ; and even in representation, it offends less than some of the disciples of ARISTOTLE are apt to suppose.

IT is difficult to assign the limits or the power of theatrical deception. Perhaps Dr JOHNSON, in his excellent piece of criticism on the *Unities*, has allowed too little force to that to which the schools had before ascribed too much. A play represented is certainly something different from a play read ; and in that representation, we are hurt with any circumstance which lets down our feelings from their ideal place, as we are, on the other hand, pleased with every circumstance which rivets and confirms them there. The dress, the decorations, the scenery, and all those little externals, which, in the cant language of the theatre, are called *property*, hurt us, if they do not correspond with the situation and circumstances of the persons whom we see before us on the scene. And this cannot be from our sense of the propriety of a theatrical exhibition, considered as such,
according

according to the rules of art ; for the little circumstances I mention are sooner perceived by an ignorant and untutored spectator than by a critical and experienced one. A critical and experienced one is indeed a very challengeable judge of the effects of this deception. He has got too much behind the scene to allow it its due impression on his mind ; and is exercising other faculties than that feeling and imagination, which the less informed spectator allows to overpower him with all the pity, the wonder and the terror, with which the poet has filled his piece. In point of deception, however, supposing what I contend for to be granted, the circumstance of *time* is, as JOHNSON very well observes, extremely pliant to the imagination. Nor is *place* perhaps less accommodating. Indeed I am inclined to think it rather more so, for this reason, that time holds a relation to ourselves ; but the mimic world of the stage, from which we draw our ideas of place, is something quite distinct from the world of the pit or boxes in which we ourselves are placed. Still, however, a violent infringement of probability in either of those particulars, offends that belief which the captive fancy wished to pay to the dramatic creation before it. The division of acts, which is very arbitrary on our stage, and not less so in some of these German productions, affords, in my opinion, an opportunity favourable to this distance of place and lapse of time, which, in both theatres, are so often indulged. When the curtain is down, and the music plays, there is a pause in our attention, a calling off of our imagination from its immediate pursuit, which sufficiently prepares both for a very considerable change of place and of time, without wounding the unity of our feeling by the discordance of the scene. In the division of our plays, and in that of the German ones I am now considering, the author is not bold enough to multiply the acts, in words, beyond the number five ; but, in truth, if by an act is understood a subdivision of the piece, consisting of a certain separate complete part, both the

English

English and German plays are frequently split into a much greater number. And I thought it a very just, as well as natural answer, which a countryman in the pit gave to a friend of mine, who entered in the middle of one of SHAKESPEARE'S tragedies, and asked him to what act they had got, "I believe, Sir, said he, they are just going to begin the ninth."

THE morals of these German plays are in general unexceptionable. There is no approach towards indelicacy, except in one or two instances in the more serious scenes, to a kind of indelicacy, arising from a want of that nice sense of dignity and decorum which the family of the muse requires. There is, however, a licence of thinking on some subjects, that tinctures pretty strongly of several of the performances in question; and by a combination not unfrequent among sentimentalists, the language is highly virtuous, while the action is libertine and immoral. From the author of the Sorrows of WERTER, this does not surprise; but in a play, written by a person of a grave character, Professor UNZER of *Altona*, one would hardly expect to have found a prayer to the virgin concluded by a solemn resolution of suicide, and the strength of mind with which the heroine looks on the poisoned beverage before her, ascribed, in the very language of devotion, to the *power and efficacy of prayer*.

BESIDES the delicacy of decorum, and propriety in the manners and the language of a play, there is a sort of delicacy in its very passions and distress, which highly polished theatres require, the neglect of which is disagreeable to the feelings and the taste of a very refined people. The sorrow that melts, not the anguish that tears; the fear that agitates, not the terror that overwhelms the soul, are the passions which such an audience relishes in a tragedy. The German theatre does not allow for this delicacy of feeling. Its horrors and its distress assault the imagination and the heart of the reader with unsparing force; it loves to trace those horrors and that distress
through

through every scene and every situation in which they can be found ; and in its display of human passions and human sorrows, is little solicitous to mitigate the atrocity of the one, or the poignancy of the other. This strong painting will sometimes disgust the delicacy of him who has been used to the finer tints of the modern school ; but it gives room for that sublimity and boldness of picture, which is often ill exchanged for the flat insipid representation of restrained passions and chastened manners.

Baron RIESBECK, himself a German, who is therefore no bad authority on this subject, accounts for the prevalence of high-wrought passion on the German stage, from the particular mode of living in Germany. “ The different classes of people, “ says he, do not mingle so much in the German towns as they “ do in France. To every thing which belongs to nobility, or “ which has the name of nobility, or is in any way attached to “ the Court, the German in middle life can have no access. “ His knowledge of life, and taste for social pleasures, is much “ more confined than that of our people, (the Baron writes in “ the character of a Frenchman), nor does he, like the inhabitants of a moderately large French town, enter into the innumerable incidents and accidents of common life. This “ want of interest in usual virtues and vices, this insensibility “ to the little events of ordinary life, oblige the German to “ look for strong emotions and caricatures to entertain him on “ the stage ; whereas the Frenchman is contented with a piece “ of much finer wrought plot, and willingly sees the people he “ lives and is acquainted with represented on the stage.”

To this account of the Baron’s may, I think, be added something peculiar in the national character, which, like that of the English, is of an ardent, thinking, serious cast. To men of this disposition, the lighter and more ordinary views of life and manners are not interesting. They call for deeper and more impressive scenes, scenes of high passion and strong emotion.

The

The Germans have accordingly adopted, with the greatest eagerness, the English tragedies most calculated to please this turn of mind. SHAKESPEARE is their favourite author, and the model of some of their most popular tragedies. To this idea, the love of sentiment I have before taken notice of, may be easily reconciled. The sentiment these plays exhibit, is not the sentiment one meets with in French authors ; it is not the nice and delicate feeling of the *petites morales*, or manners ; it is that deep impassioned sensibility, which resides in serious and ardent minds, which can brood with melancholy, or kindle with enthusiasm.

IN the German comedy, somewhat of the same thoughtfulness, phlegm perhaps a Frenchman might call it, may be traced. We find not the gay and sportive language with which the comic muse of France forms her lively and elegant dialogue ; not those nice and delicate tints with which her light and flying pencil marks the pictures of her scene ; but a style more serious and reflective in the one, and colours more strong and hard in the other.

A CIRCUMSTANCE very observable in the German theatre, is the frequent minuteness and prolixity of the scene. This is naturally the case in an early and unrefined period of the drama. To select striking and luminous parts of a story, or of a series of actions, to exhibit those in one strong point of view, and to leave the subordinate parts to be filled up by the imagination of the reader or the spectator, is a sort of abstraction which belongs to a more advanced and cultivated period. In the first rude essays of painting, one picture contains different actions of the same persons ; and, in early narrative, every circumstance that passed, and every word that was uttered by the persons of whom the relation speaks, is introduced. In dramatic poetry, in the same way, the earlier and less cultivated poets are not contented with shewing the persons of the drama only in the great and important scenes to which the

course of their story leads; they exhibit every concomitant scene in which those persons may be supposed to have been concerned. The more inventive imagination an author possesses, the more he is liable to this fault, if that imagination is not chastened by learning, and regulated by taste. RICHARDSON, who may perhaps be ranked next to SHAKESPEARE among our authors of untutored genius, is an instance of this in later times. His painting is always in nature; but his canvas is often filled with unnecessary figures, which add to the size, while they diminish the effect of the picture. SHAKESPEARE (as might more readily be expected) is in this particular extremely faulty; and his German admirers have not corrected this fault in their imitations of him. They are more defective than he in what may be called the unity of dialogue, *i. e.* in making their personages speak only what is natural and important to their situations, and to the conduct of the piece; an error to which several of their scenes owe a degree of languor, as well as length, which is apt to fatigue the reader, and must have required very good speaking indeed, not to have tired the audience.

THE style of these volumes is in general bold, forcible and rich; in some places perhaps rather too florid and ornamented. This is apt to strike us more in prose, in which most of the pieces in these collections are written, and into which they are all translated, than it does in verse; because elevation of language is more expected in the latter than in the former. It has been generally held as a maxim in dramatic dialogue, that the pathetic should be expressed in the simplest language; that description and moral sentiment may admit of the pomp of verse and the ornaments of eloquence, but that passion and distress do not allow of such decorations, because they bring the mind into a situation which swelling or figurative language does not suit. This is evidently just to a certain degree. The mind, occupied with, and full of its own feelings, has no leisure to
study

study the expressions in which those feelings are vented ; yet I think it will be found in nature, that a certain elevated diction will often be that in which the mind will pour its most genuine and deepest sorrows. There is a pride and dignity in sorrow which renders it eloquent ; which, rising above the level of ordinary things, speaks in a style more lofty than that of common life. I believe it will also be found, that, in composition, the assumed loftiness of language will have some effect in producing a loftiness of idea ; that “ the words that glow ” will sometimes, as it were, create “ the thoughts that burn.” I think it is PLATO who, somewhere in his works, makes a remark of this kind as to poetry, whose measure and majestic march give an inspiration to the poet, which the train of thought in common language would not have produced. And I am persuaded that the dramatic writer who, in the fervour of composition, gives to the distresses of his fancy a language of that elevated kind, will sometimes, in the very flow and current of his words, feel his heart swell, and tears gush from his eyes, with an energy of passion which a more ordinary diction would have failed to rouse. It must, however, at the same time, be confessed, that the most common fault lies on the opposite side ; and that authors of but moderate genius often invest their characters, rather in the parade of words than in the dignity of sentiment, rather in a coldly imitative phrase of feeling than in feeling itself. A fault of this kind is sometimes discernible in the dramas before us, where, in the development of sentimental distress, the characters talk rather than feel their situation ; where the poet, refining on his art, rather colours than draws the picture of the scene, or, to pursue the allusion, gives us shades of language instead of shades of thought.

THIS laboured display of sentiment and sensibility is liable to the general objection which strikes one in every dramatic performance, as lying against the persons of the drama in-

forming us of what passes in their minds, not by what the scene shews in their actions, or what the situation naturally leads them to say, but, if we may be allowed to resort to the plain honest confession of Mr BAYES, in order to give an opportunity of introducing *good things*. To this fault, the simple and the polished state of the drama are equally liable; the first from that chace of images and analogies which the luxuriance of fancy dictates, and which taste has not yet taught her to restrain; the other, from a rigid observance of order and unity, which adds to the narrative in proportion as it limits the exhibition of the scene. We find accordingly this defect in many passages of the older poets; and not less, and indeed in a much more continued strain, in the modern dramatists, particularly the French, where the *tirade*, or string of fine lines, is often introduced, not to express the feelings of the speakers, but merely to shew the eloquence of the poet.

IN my enumeration of the pieces contained in this collection, I mentioned, that most of those which are called comedies, rather come under the denomination of *dramas*, containing a delineation of the affections and passions of ordinary life, more allied to tragedy than to comedy, being only related to comedy in its persons, but to tragedy in its sentiments and its sufferings. Its sufferings, however, are rather of feeling than of situation, which is one great reason of the interest it excites in that class of people, a very amiable one, whose minds from nature, reading, or habit, possess an excessive and high strained delicacy and sensibility. The situation and distresses of the persons represented in it, are but little removed from the situation in which that class of readers are placed, or those distresses which they often feel. Hence perhaps no species of the drama may be supposed to have a stronger effect on actual life and conduct. This might lead to an interesting moral inquiry, for which the present is not the proper place, and which indeed has not been unnoticed by several late moral writers. In general,

I think we may venture to pronounce these dramas favourable both to moral principle and to the practice of virtue. To the former, they are allowed, even by their adversaries, to be friendly; to the latter, it may perhaps be contended that they do not always contribute, or at best that they only produce that momentary impression, which passes over the mind like a golden dream, amusing to the fancy, but without any effect on our actual conduct or dispositions. The French dramas of this species, and some of the German ones in this collection, which seem to have been formed on these models, have a good deal of that pompous wordy declamation of virtue and sensibility, which, like every species of bombastic writing, is extremely popular at its first introduction, and generally maintains a number of partizans, even when assailed by the weapons of criticism or good sense. Such a common-place sort of weakness hurts equally the good effects of the drama, as a lesson of morals, and the entertainment to be derived from it as a work of taste. To the enemies of virtue, the ridicule is open; to her friends, the exhibition is painful; it is like the dotage of a person we love, which, though we cannot laugh at, we are constrained to blush for. Besides, in moral effect, it loses the advantage which, as I observed above, this species of drama possesses, of approaching nearer than any other to ourselves. When we see so little truth or life in the picture, when the sentiments soar so airy a height, we feel them as those of another world, which, if we should even admire, we will never concern ourselves to imitate.

It must, however, be confessed, that though such weak passages will naturally produce those effects among people of better informed judgments and more ripened taste; yet, by the less refined part of an ordinary audience, they are often received with that genuine feeling and applause, which, as they are produced by virtue, are friendly to her interests. At the representation of some of those scenes, where very laudable,

ble, but very common-place maxims, were pompously brought forth, and received with loud plaudits, I confess, though I thought meanly enough of the genius of the poet, I have thought, and been happy while I thought, highly of the people. The people, whose opinions may often be folly, whose conduct may sometimes be madness, but whose sentiments are almost always honourable and just; the people, whom an author may delight with bombast, may amuse with tinsel, may divert with indecency, but whom he cannot mislead in principle, nor harden into inhumanity. It is only the mob in the side-boxes, who, in the coldness of self-interest, or the languor of out-worn dissipation, can hear unmoved the sentiments of compassion, of generosity, or of virtue.

IN examining these pieces in detail, and appropriating them to their respective authors, one is immediately struck with the name of LESSING, whom Germany so much reveres as one of the founders of her drama. He is the author of the first piece in FRIEDEL'S collection, *Emilie de Galotti*, another tragedy in one act called *Philotas*, a third called *Sara Samson*, and a drame entitled *Nathan le Sage*. He is author also of several other plays contained in the Theatre Allemand of JUNKER, one of which, *Minna de Barnhelm*, is reckoned the *chef d'œuvre* of German comedy. I have perused it with all the attention to which its high character entitled it, and indeed with a great degree of the pleasure, though not with all the admiration which that high character led me to expect. It is of the graver or sentimental kind of comedy, where the characters maintain a war of generosity, from which the embarrassments and implications of the plot, not very intricate nor artificial ones, result. The principal person is a Major TELHEIM, a disbanded officer, whose merits his country had ill rewarded; a man of the most consummate bravery, generosity and virtue, for whom those qualities have gained the love of every soldier and domestic around him. They have procured him a still more valuable attachment,

attachment, the love of the heroine of the piece, MINNA of Barnhelm, who, on hearing of the Major's regiment being disbanded, comes to Berlin to seek him, and to make him happy. The rival nobleness of mind of these two characters produces the principal incidents of the piece, which, however, are not always natural, nor very happily imagined; and besides, as FIELDING jocularly says, when comparing a shallow book to a shallow man, may be easily seen through. But, with all these defects, and that want of comic force which the turn and situation of the principal characters naturally occasions, the play must please and interest every reader. There is something in the constitution of the human mind so congenial to disinterestedness, generosity and magnanimity, that it never fails to be pleased with such characters, after all the deductions which critical discernment can make from them. Amidst the want of comic humour which I have observed in this play, I must not omit, however, doing justice to a serjeant-major of TELHEIM's regiment, and to JUSTIN his valet, who are drawn with a strong and natural pencil. The story of the spaniel, told by the latter, when his master's poverty makes him wish to dismiss him from his service, is one of the best imagined, and best told, I remember to have met with. There is a good deal of comic character and lively dialogue in some of LESSING's less celebrated pieces in the collection of JUNKER; but the plots are in general extravagant and farcical.

IN judging of LESSING as a tragic writer, one will do him no injustice by making the tragedy of *Emilie de Galotti* the criterion of that judgment. The others in these volumes are very inferior to this, which is certainly, in point of composition, character and passion, a performance of no ordinary kind. LESSING was well acquainted with the ancient drama, and wished to bring the theatre of his country to a point of regularity nearer to that of the ancients. He published, for some time, a periodical criticism on theatrical composition, called,

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“ *Le Dramaturgie de Hambourg.*” His plays, accordingly, though not exactly conformable to the Aristotelian standard, approach pretty near to it in the observation of the unities. He is said to have got into a dispute with GOETHE on this subject, in which, from a degree of timidity in his nature, he rather yielded to his antagonist. I am not sure if he has profited by confining himself more than some other of his countrymen within the bounds of the regular drama. The fable of *Emilie de Galotti*, as well as of his other tragedies, is more regular than happy, and the denouement neither natural nor pleasing. It is founded on circumstances somewhat similar to those in the story of *Virginia*. A Prince of Guastalla is desperately enamoured of EMILIE DE GALOTTI, who is just about to be married to a man of rank and fortune, the Count APPIANI. On the day of his marriage, he is way-laid by order of a wicked minister of the prince, and murdered. His bride is brought to the Prince’s country-seat, where, to prevent any chance of her dishonour, her father kills her.

AFTER the first reading of *Emilie*, I was disposed to wonder at the reputation it had acquired; but a second placed it higher in my estimation. This was naturally the case in a performance where the whole was neither so perfect nor so interesting as some of the scenes in detail were forcible and striking. The heroine EMILIE DE GALOTTI is but imperfectly drawn, and not very well supported. Indeed, it may in general be observed in these pieces, that the characters of the female personages are by much the most defective, both in beauty and in force. This may perhaps be ascribed to the state of society in Germany, where the sex is less an object of consideration and respect than in France, and some other parts of the Continent. But there is another lady in this tragedy, the *Countess d’Orsina*, the betrayed and abandoned mistress of the Prince, whose character the poet has delineated with great ability; and one scene, in which she is introduced along with the father of

EMILIE,

EMILIE, in genuine expression of passion, and pointed force of dialogue, may be compared to some of the best which the modern stage can boast.

IN the developement of the secret foldings of the heart, LESSING seems deeply skilled, and the opening scenes of this tragedy contain some of those little incidents that mark an intimacy with human nature, which genius alone can claim. But in its progress we find, in some degree, a want of that strong and just delineation and support of character, but chiefly of that probable conduct and interesting situation, which are the great and peculiar requisites of dramatic excellence. It seems also defective in the pathetic, for which certainly the subject afforded very great room, and which, in a similar situation, our countryman ROWE has contrived so strongly to excite.

OF LESSING's performances in these volumes, the next in merit, though, in my opinion, at a considerable distance, is *Sara Samson*, an English story, of which the idea seems chiefly taken from *Clarissa*, though one character in it, that of a violent and profligate woman, is evidently borrowed from *Millwood* in *George Barnwell*. I must venture to doubt, whether a character of this sort be proper for filling a principal place in tragedy. There is a degree of infamy in the vice of such a person that is scarcely suitable to the dignity of the higher drama, and which disgusts us with its appearance. The *Marwood* of LESSING is introduced in such a manner as to heighten that disgust. The amiable female of the piece, *Sara Samson*, is no exception from the general defect of female character in this collection. And her father, who is placed in the tender situation of which several authors have made so affecting a use, the parent of a child seduced from honour, though still alive to virtue, is insipidly drawn, and awkwardly introduced. In this tragedy, is an incident, of which LESSING seems to be fond, as he has repeated it with very little variation in another tragedy called *L'Esprit Fort*, a dream, related by the heroine, pre-

dictive of the catastrophe. This, as it anticipates the conclusion, is always faulty. No part of the conduct of a play is more nice and difficult than that degree of information which the author is to give the audience in the course of it. In general, he should certainly not forestal their expectations, by opening his plot too soon. But there is an admirable theatrical effect which often results from letting the audience know what the persons of the drama are ignorant of, which stretches, if I may use the expression, the cords of fear, anxiety and hope in the spectators to the highest pitch, through scenes which otherwise would produce these feelings in an inferior, as well as in a momentary degree. This knowledge in the audience, of *Merope's* son, while she, in ignorance of his person, is on the point of putting him to death, is one of the most interesting situations which dramatic invention has ever produced; and there is nothing on the French stage which equals the horror of that scene of CREBILLON's *Atree et Thyeste*, where the devoted brother attempts to disguise himself from *Atreus*, while the terrified spectators know him all the while, and tremble at every look and word which they think will discover him.

NEXT to LESSING, in point of name, is GOETHE, the author of two tragedies in this collection, *Goetz de Berliching* and *Clavidgo*, and of a drama entitled *Stella*. The first I have already mentioned as highly irregular in its plan, being a life thrown into dialogue rather than a tragedy. The *costume* of the age in which the events are supposed to have happened, is very well preserved. The simple manners, the fidelity, the valour and the generosity of a German knight, are pourtrayed in a variety of natural scenes. This national quality, I presume, has been the cause of its high fame in Germany, to which it seems to me to have otherwise not a perfectly adequate claim. His *Clavidgo* is founded on an incident which happened to the celebrated CARON DE BEAUMARCHAIS in Spain, who is introduced as a person of the drama, under the name of *Ronac*,

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an anagram of *Caron*, with the letters a little transposed. The distress of the play arises from the falsehood of a lover, who leaves his mistress after being engaged to marry her. Neither the delineation of the characters, nor the management of the plot in the first two acts, is entitled to much applause; but the last act, which passes in sight of the corpse of *Maria*, is wrought up with uncommon force, and must, on the stage, be productive of high effect. His third performance, *Stella*, is strongly marked with that enthusiastic sentiment and refined sensibility, which, in the *Sorrows of Werter*, he has so warmly indulged; and in point of immoral effect, the drama is equally reprehensible with the novel. Its conclusion is in the boldest style of this sentimental refinement; since it gives to the hero two wives, with whom he is to share that heart, to which the incidents of the play have shewn the claims of both.

AFTER LESSING and GOETHE, BRANDES seems to be the author in these volumes next entitled to notice, and indeed, in my opinion, the least exceptionable of them all. His two comedies, *Le Comte d'Olbach*, and *L'Hotel Garni*, are highly interesting in their fable, spirited and natural in their dialogue, and contain situations and incidents truly theatrical, and extremely affecting.

AMONG the comedies of these volumes, is a very pleasant one, entitled *Le Greancier*, by Mr RICHTER. A paragraph in his preface is worthy of notice, as it strongly marks the prevailing tendency of the German taste in theatrical performances. "In these days, says he, when all the world reads SHAKESPEARE and GOETHE, a drama like mine, which contains no outrageous passions, of which the style is neither metaphorical nor bombastic, which ventures to follow the good old Aristotelian rules, so long exploded among us, can hardly hope to please the *Aristarchuses* of our modern school.

“ It is true, I might observe to these gentlemen, that an honest banker, who has not lost his wits, will, in all probability, neither speak nor act like *King Lear*, nor his clerk like *Jago*, nor his daughter’s maid like the confidante of Queen *Cleopatra*. But these old fashioned observations would probably not save my poor comedy from condemnation.”

THERE is one little piece in the collection of FRIEDEL, which every reader must applaud, even if his applause had not been anticipated by the judgment of the late King of Prussia, who pronounces it the only very good German comedy. This is the *Atte-lage de Poste*, by Colonel EMDORFF, an officer in the Imperial service. The plot is founded on the violent love for horses of a German Count, who barter his mistress with his rival for a set of carriage-horses. The characters are truly comic, the incidents highly amusing, the dialogue infinitely easy, lively and natural, and so perfectly appropriated to the speakers, that one might ascertain the persons, though their names were not affixed to the speeches.

BUT the most remarkable, and the most strongly impressive of all the pieces contained in these volumes, is that by which the collection of Mr FRIEDEL is closed, *Les Voleurs*, a tragedy by Mr SCHILLER, a young man, who, at the time of writing it, was only twenty-three. Bred in the *Ecole Militaire* of *Wurtemberg*, he had little opportunity of informing his mind by letters, or of knowing mankind by observation. But amidst the cloistered ignorance incident to his situation, his genius, by its own native warmth and vigour, produced this wonderful drama, which shews indeed, as might be expected, a certain want of acquaintance with the manners, as well as a total disregard of dramatic regularity, but in which the author, fortunate, if we dare say so, in these defects, has drawn from the sources of an ardent and creative imagination, characters and situations of the most interesting and impressive kind, and has endowed those characters with a language in the highest degree

gree eloquent, impassioned and sublime. With a particular detail of this tragedy, I shall close the account (I am afraid a very imperfect, though without the apology of being a short one) which I have taken the liberty to lay before this Society, of the *Theatre Allemand*.

A YOUNG man, of high birth and expectations, *Charles*, eldest son of the *Comte de Moor*, endowed by nature with a soul of fire and a heart full of sensibility, is led away, in the prime of youth, by the love of pleasure and dissipation too common at that age. After running a course of thoughtless and criminal extravagance, he listens to the voice of virtue, which had been stifled, not lost, in his heart, and writes to his father, whom amidst all his vice and folly he had never ceased to love, a letter full of penitence and contrition, desiring to return to his duty, and to be received again to pardon and to favour. This is intercepted by the villany of a younger brother, who manages so as to persuade his father that his son *Charles* (who appears to have been his great favourite) is totally abandoned to villany and vice; in consequence of which, the old man throws him utterly from his regard, and sends him a letter renouncing him for ever, and containing that paternal malediction, so dreadful to the sensibility of a son who loved his parent. On receipt of this, *Charles* becomes desperate; and, amidst the storm of his feelings, outraged by what he thinks the inhumanity of his father, readily accepts of a proposal made by some of his dissipated companions, to leave a world in which they had nothing but contempt and poverty to expect, to fly to the forests of Bohemia, and there to establish themselves into a society of robbers and banditti, of which he was to be the chief. In the horrid duties of this new employment, he shews all that wonderful magnanimity, that persuasive eloquence, that undaunted valour, which would have graced a better station; yet amidst the elevation and activity of mind with which the exercise and the success of these qualities

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are accompanied, his heart is pressed down by remorse, and melted by the tender recollection of that virtuous happiness which, in the days of youth and innocence, he had once enjoyed. The curse of a father whom he had revered and loved, the desertion of a mistress, a cousin of his own, of whom he was desperately enamoured, the sense of his outcast and abandoned situation, and of those violations of virtue and morality to which it necessarily leads; those rending feelings, those melting remembrances, joined to that high sense of perverted honour which links him to his band, and that ardent valour which makes their enterprises of glory; these form a character of the most energetic and interesting kind, and the author has given to his hero a loftiness and power of expression fully adequate to the terrors and the passions which his situation and his feelings produce. The intrinsic force of this dramatic character is heightened by the singular circumstances in which it is placed. Captain of a band of inexorable and sanguinary banditti, whose furious valour he wields to the most desperate purposes; living with those associates, amidst woods and deserts, terrible and savage as the wolves they have displaced; this presents to the fancy a kind of preternatural personage, wrapped in all the gloomy grandeur of visionary beings.

BUT to return to the narrative of the tragedy.

His younger brother *Francis* having succeeded in removing this favourite of his father, now looks to the death of the old man as the complete accomplishment of his wishes to attain the fortune and honours of his family. To effect this hellish purpose, he makes use of his father's still remaining tenderness for that very son whom the traitor's arts had driven from his love. He employs one *Herman*, a tool of his villany, to personate a soldier, who had been the companion of *Charles*, and to relate a fabricated story of the sufferings and death of that unfortunate young man, who, according to him, had been reduced, by the severity of his father, to the most extreme and pitiable indigence,

gence, from which he had at last been relieved by death, having fallen fighting gallantly in an action with the infidels, and in his last words had breathed out the name of his father and of his *Amelia*. The old Count feels this relation as his inhuman son expected; he faints at its close, and is carried off lifeless from the stage. The traitor *Francis* reaps the fruit of his villany; he reaps, but his conscience does not permit him to enjoy it; and he is ever after presented as the martyr of remorse, haunted by the terrors of inward guilt. His associate *Herman* appears to yield to contrition; he braves the anger of his lord, and resolves to embrace the first opportunity of counteracting his villany.

THOUGH the great and the terrible be the most prominent features of this drama, there are scenes in which the pathetic and the tender prevail in a very uncommon degree; and the impression they make on the reader is heightened by the contrast of that bold unbending spirit which he sees melted by their force. One of these, the second scene of the third act, is so striking, that I cannot forbear laying it before the Society in English. They will make allowance for what it must lose in this form, when they consider that it is the translation of a translation.

THE band are encamped on a height on the banks of the Danube, after a hard-fought battle with a party of Bohemian horse, which had been sent to take them; but which, by the unparalleled valour and exertions of *Moor* and his friends, they had defeated. He enters, overcome with fatigue and thirst.

“ I MUST rest here, (*throwing himself on the ground*); my limbs are broken with fatigue, and my parched tongue cleaves to my mouth. I would have asked some of you to fetch me a little water from that river, but you too are weary almost to death. (*One of the band goes out, unperceived by Moor, to fetch him some water.*)

“ Grim,

" *Grim, (another of his band)* 'Tis a long time since our flasks
 " were empty of wine. How majestically the sun sets there
 " below!

" *Moor, (looking stedfastly on the setting sun)* 'Tis thus that a
 " hero dies, and the nations admire his fall!

" *G.* It seems to move you.

" *M.* IN my youth, it was my favourite idea to live like
 " him, (*looking earnestly on the sun*) to die like him! 'Twas the
 " fancy of a young man.

" *G.* 'Twas even so.

" *M.* THERE was a time—(*drawing his hat over his eyes*)—
 " leave me alone, my friends.

" *G.* MOOR, MOOR! do you ail aught? Your colour
 " changes.

" *M.* THERE was a time when I could not sleep if I had
 " forgot my prayers before I laid me down.

" *G.* 'Tis folly all—Would you, like a boy, be schooled by
 " the remembrance of your infant days?

" *M.* MY infant days! Oh! (*leaning his head on the bosom of*
 " *Grim.*)

" *G.* THINK of these no more. Be not a child again, I pray
 " you.

" *M.* A child again! Would that I were!

" *G.* ROUSE yourself for shame! See how the landscape
 " smiles—how beautiful the evening looks!

" *M.* AYE, my friends, this earth is so beautiful—

" *G.* WHY, that is well.

" *M.* THIS scene so grand—

" *G.* You speak it truly. I love to hear you talk thus.

" *M.* AND what am I, in this world that is so beautiful!
 " A thing so vile on this magnificent work of heaven!—The
 " prodigal son!

" *G.* MOOR! MOOR!

" *M.*

“ M. My innocence—give me back my innocence. Look
 “ how every thing in nature is cheered by the smile of spring.
 “ Why in this air, so pure to them, should I breathe the
 “ blasting smoke of hell? When all around us are happy—
 “ when gentle peace has united them—the world one blessed
 “ family, and its Father there above—who is not my Father!
 “ I alone shut out—the prodigal son—excluded from the por-
 “ tion of his children—(*shrinking back with horror*) surrounded
 “ with crimes—with murder—bound to them with chains of
 “ iron.

“ G. (*to the rest of the band*) I never saw him thus before.

“ M. (*with a voice of tenderness*) AH! if it were possible for
 “ me to be born again—to be born a beggar, the meanest
 “ thing that were not a guilty one! With the labour of these
 “ hands I would purchase the weariness of peace. Oh! that
 “ with the sweat of my brow, though that sweat were blood,
 “ I could buy one guiltless hour—the luxury of one tear!

“ G. PATIENCE, friends; his fit is almost over.

“ M. THERE was a time when my tears flowed freely. Oh
 “ peaceful days!—that saw me in my father’s house, in my
 “ native fields!—Ye smiling fields!—ye valleys made for en-
 “ thusiasm to wander in! Scenes of my happy infancy—will
 “ ye never return? Will ye never breathe on this burning bo-
 “ som your gales of peace and joy?—Nature, why art thou
 “ dark around me?—They will never, never return; never on
 “ this bosom will they breathe—they are gone—gone for
 “ ever!”

SUBDUED by the tenderness of the recollection which this scene expresses, *Charles* visits his native castle in disguise; he finds his father dead, his brother *Francis* in possession of his inheritance, and his mistress ready to take the veil. After yielding for a while to those softer feelings which the scenes of his infancy recal, he recollects the outcast abandonment of his

own situation, makes himself known, at the instant of parting, to his *Amelia*, and flies to rejoin his desperate associates.

IN this situation of things, the fourth act commences. The scene is of that savage kind, which prepares the imagination for the horrors to ensue. 'Tis night; and the remains of the band are assembled on a desert heath, near to the ruins of an ancient tower, round which the winds whistle, and the owl shrieks. They had watched three days and nights of danger and alarm, and all, except their unhappy chief, whom remorse and anguish keep awake, yield to their fatigue, and lay themselves on the ground to sleep. *Moor* remains alone, and walks to and fro, like the sovereign spirit of the night, revolving in his troubled, but daring soul, this world and the next. In this world, he has now nothing left to hope, and he looks, with desperate calmness, on the dark and unknown gulph of that to come. His soliloquy is of that sublime and broken sort which expresses the agitation of a great but erring mind, yielding to remorse for crimes which have stained his life, but not corrupted his soul, and left him, amidst the outrages of violence and vice, the sentiments and the sufferings of virtue and of feeling. After a pause of gloomy meditation, he breaks out in the following words, (to my translation of which the Society will afford the indulgence I formerly solicited.)

——“ A LONG long night!—on which no morning will
 “ ever dawn! Think ye that *Moor* will tremble? Shades of
 “ the victims of this assassinating sword! I see your bleeding
 “ wounds, I look on your livid lips, and hear the last agoniz-
 “ ing groans they breathe—but I tremble not.—These are but
 “ links of that eternal chain, which he who sits in yonder
 “ heaven holds in his hand. He stamped these horrors on my
 “ destiny. Even amidst the innocent, the happy days of my
 “ unfulfilled infancy, his eye saw them, and sealed them on my
 “ fate! (*he draws a pistol*) The barrier betwixt eternity and
 “ time, this little instrument can burst—and then—Thou
 “ dread

“dread unknown! whither wilt thou lead? where wilt thou place me? If thou leav’st me this conscious self, ’tis that must create my heaven or my hell. Amidst the waste of a world which thine anger has destroyed, I can people the silent void with thought. Or wilt thou, in new and untried states, lead me through various misery to nothing? Thou mayest annihilate my being; but while this soul is left, will not its freedom and its force remain? ’Tis equal where—” (*putting up his pistol*) “I will not now shrink from the sufferings of the present—the destiny of *Moor* shall be fulfilled.”

HE is silent—he hears the tread of approaching feet, and presently a figure glides before him, and knocks at the grated wicket of the tower. The figure speaks, “Rise, man of sorrow, inhabitant of the tower, thy repast is here.” A feeble voice answers from the dungeon within, “*Herman*, is it thou? Bring’st thou, like the prophet’s raven, his food to a lingering wretch, that lives by the crumbs which thy pity affords him?” *Moor*, who had shrunk back in amazement, now advances, and desires the man to stop. That man is *Herman*. He draws his sword; but is almost instantly disarmed. “What art thou, says the astonished *Herman*, whose touch withers like that of death? Art thou the demon of this horrid place? the spirit of this murderous tower?” “I am, says *Moor*; the exterminating angel is my name; and yet I have flesh and bones like thee. But what wretch is in that tower? I will burst his chains.” He draws from his pocket the pass-keys which his profession employs; he opens the tower; the skeleton figure of a famished wretch creeps from the dungeon—“Horrible phantom!” says the astonished *Moor*, in a low and stifled voice, “my father!”

IT is his father, whom the inhuman *Francis* (taking advantage of the long faint into which the account of his son’s death had thrown him) had buried alive in the dungeon of the tower. When *Charles* is informed of this, and his other

treacheries, by *Herman*, the penitent associate of his villany, he wakes his band, and, in the rage of filial revenge, dispatches one of the boldest of the troop to force the castle of his brother, and bring him alive before them. The old man is still ignorant of his deliverer's being his son, and waits, terrified and weak, the disclosing of this mystery of justice and of vengeance.

THE last act opens with a scene in the castle of the guilty *Francis*, who is now in possession of the county of *Moor*. He is exhibited in all the dismay and distraction of awakened remorse. After some incoherent dialogue (wrought up with the liveliest circumstances of guilty terror) with a servant, who had watched his sleep, and followed him, when he had started from his bed, into the saloon of the castle, they are told by a frightened domestic, that a troop of horsemen are approaching at a gallop, with terrifying shouts. The Count is petrified by his guilty fears, and cannot give orders for defence. His followers, however, for a while dispute the passage of the band, till the castle is set on fire. Its master is still more lost in the horrors of his situation; and, after an unavailing request to his servant, to save him from the vengeance of his enemies, by putting him to death, is left alone amidst the approaching flames, wishing to die, yet dreading death, till he hears the thunder of the band at the gate, which shakes, bursts, and the entering foe seizes him alive, and carries him off, according to the command of his captain.

THE scene changes to the heath, where *Moor* and his old father are discovered amidst the war of contending feelings with which the son is torn. He often resolves to disclose himself to his father: but the consciousness of his fallen and abandoned state withholds him. The poet has contrived, by placing the father and son in this particular situation, to infuse into this scene a degree of tenderness which melts the heart, mixed with a horror which chills the imagination. When the old man
complains

complains that he has now no son to close his eyes, his son throws himself on the neck of his father, yet is unable to discover that this wretch, this robber, this assassin, is his *Charles*. At that moment, a distant noise is heard, and presently the dim gleam of torches begins to illumine the scene around them. The glare of their light increases; the voices are heard more near; the accustomed music of their savage triumph sounds; and the faithful band of *Moor*, true to their commission of vengeance, bring the criminal *Francis* chained before his father and his brother. It is impossible to convey by narrative the horrid sublimity of the situation which this scene presents, or of those expressions to which the wounded sensibility of *Moor*, wrought up to the most insatiable revenge against the author of his father's misery and his own, gives birth. The reader could hardly conceive any modern imagination, how pregnant soever with tragic terrors, to produce a scene that could vie with the dread picture of the fourth act; when he has read the fifth, he will find the horror equalled, and the interest surpassed.

Moor leads the wretched *Francis* before his father. The old man is willing to forgive him; but his brother has devoted him to vengeance. He desires the band to lead his father to a remote part of the wood; and then, settling the fury of his revenge into the terrible solemnity of dispassionate justice, he places his brother in the midst of his fierce associates, and desires them to pronounce sentence on his crimes. They consult some time together on an adequate punishment; and then, felicitating themselves on the thought, they throw him into the dungeon in which this barbarous parricide had buried his father. The old man is brought in. He feels the yearnings of paternal affection for his guilty son, and exclaims against the cruelty of his avengers. *Moor* throws himself into his arms, and discovers to him his favourite, his *Charles*. Just then, *Amelia*, who had escaped from the castle of his brother, enters,
and

and runs to embrace her lover and his father. The father feels all the pleasure of his son and his niece restored, and fondly anticipates the felicity they are to enjoy. But *Moor* bids them check the expectation of happiness, and look only for desperation and horror. "Your paternal curse, says he, consigned me to perdition. These men you see are robbers—murderers—your son is their chief." The exhausted strength of the old man cannot stand the shock; he expires in the arms of his son. His mistress still survives; and though dumb with terror and grief, folds him in her arms, and shews the most ardent affection for her *Charles*. Warm in his love, as in every other feeling, *Moor* had doated on her to distraction; he forgets himself in her embraces, and for a moment thinks he will live and be happy with his *Amelia*. "Come from her arms," cries one of the boldest of his troop, or I will speak what shall freeze your blood." "Think, exclaims another, (while they level their pieces at his head) of your vow to be ours for ever. Ours you are, and heaven nor hell can win you from us." Their voices rouse the remembrance of his situation. But his soul is too proud to yield to threats. "You are murderers, says he, and I am your chief. Down with these arms, and know your master." Awed by the sounds they are accustomed to obey, the banditti lower their arms.—"To be great, *Moor* must be free. I would not give this triumph for all the elysium of love. (*He draws his sword.*) Call not that madness of which your souls want strength to see the grandeur. The greatness of despair is above the ken of wisdom. On actions such as this, reflection must follow, not wisdom pause."

He plunges his sword into the bosom of *Amelia*. Struck with the barbarous heroism of the deed, his associates fall at his feet, acknowledge his unparalleled fidelity, and vow to be his slaves for ever. "No, says he, with a determined and petrifying calmness; the destiny of *Moor* is accomplished.

"Thus

“ Thus far it was in human power to go, and thus far he has gone ; but here his course is closed, and his genius cries out, “ *All is consummated.*” He dismisses his band, except two favourite officers, with an exhortation to use their invincible courage in the service of their country. To these two favourites, whose souls are not so deeply tinctured in blood, he bequeaths his paternal domain, and desires them to leave him, and to devote their future lives to virtue and obedience to the laws. “ And “ I too, he concludes, will obey the laws ; I will bear the “ sternest punishment of their decree.” And he goes to deliver himself up to justice.

I HAVE ventured this long and particular account of the tragedy in question, because it appears to me one of the most uncommon productions of untutored genius that modern times can boast. Confessedly irregular and faulty, both in plan and conduct, it were needless, and perhaps unfair, to offer any remarks on its defects. But its power over the heart and the imagination must be acknowledged. Every body has heard the anecdote of its effects on the scholars at the school of *Fribourg*, where it was represented soon after its first appearance. They were so struck and captivated with the grandeur of the character of its hero *Moor*, that they agreed to form a band like his in the forests of Bohemia, had elected a young nobleman for their chief, and had pitched on a beautiful young lady for his *Amelia*, whom they were to carry off from her parents house, to accompany their flight. To the accomplishment of this design, they had bound themselves by the most solemn and tremendous oaths ; but the conspiracy was discovered by an accident, and its execution prevented.

THE energy of this tragedy's effect is not to be wondered at, especially on young minds, whose imaginations are readily inflamed by the enthusiasm of gigantic enterprise and desperate valour, whose sensibility is easily excited by the sufferings of a
great

great unhappy mind, and who feel a sort of dignity and pride in leaving the beaten road of worldly prudence, though the path by which they leave it may sometimes deviate from moral rectitude. But hence, to some parts of an audience, the danger of a drama such as this. It covers the natural deformity of criminal actions with the veil of high sentiment and virtuous feeling, and thus separates (if I may be pardoned the expression) the *moral sense* from that morality which it ought to produce. This the author has, since its first publication, been candid enough to acknowledge, and reprobates, in terms perhaps more strong than it deserves, his own production as of a very pernicious tendency. He has left his native country, *Wirtemberg*, from which I believe indeed some consequences of the publication of this tragedy had driven him, and now lives at *Manheim*, where he publishes a periodical work, and has written one or two other tragedies, which have a high reputation. If his genius can accommodate itself to better subjects, and to a more regular conduct of the drama, no modern poet seems to possess powers so capable of bending the mind before him, of rousing its feelings by the elevation of his sentiments, or of thrilling them with the terrors of his imagination.

VI. THEORY of the MOODS of VERBS. By JAMES GREGORY, M. D. F. R. S. EDIN. *Fellow of the Royal College of Physicians, and Professor of the Theory of Physic in the University of EDINBURGH.*

[Read by the Author, June 18. and July 16. 1787.]

IN the prosecution of certain philological and philosophical speculations, very ample specimens of which have already been submitted to the consideration of the Royal Society of Edinburgh, I had occasion to consider more minutely than I believe had ever been done before, many particulars relating to the nature, the structure, and the import of Verbs.

THOSE speculations related chiefly or solely to the general radical import of every verb and every class of verbs, without any regard to the peculiar meaning or nature of the various inflections or parts of a Verb; such as, moods, tenses, persons and numbers. It was impossible, however, for me altogether to avoid attending to these modifications of the general meaning of every Verb; especially to the nature and import of the Moods of verbs, which appears to me a very curious and interesting point in the theory of language.

As I had not the good fortune to meet with any account of the Moods of verbs, which appeared to me complete or just, in the writings of those grammarians and philologists that I have had an opportunity of consulting, I was tempted to undertake the investigation of the nature of them myself. The result of

that undertaking I now have the honour to submit to the consideration of the Royal Society.

As there is something peculiar in the plan and manner of it, it is proper to mention the reason of this peculiarity. In those accounts of the moods of verbs which I have seen, there seemed to be a want of sufficiently numerous and extensive and accurate observations of the particular facts that were to be explained or accounted for; a want of sufficiently precise and distinct notions of the general import of the moods; a hasty and careless admission of certain general principles not duly ascertained, and a vague use of certain general and comprehensive terms, which were not sufficiently explained or understood.

IN order to avoid these errors, and to supply these defects, I have proceeded on a plan more nearly akin to that which has long been successfully employed in physical investigations; beginning with a collection of observations relating to the moods of verbs; from these deducing certain general principles, and verifying these principles by further observation, and even experiment. Such a plan is undoubtedly laborious, and may appear tedious; but I think it has advantages amply sufficient to compensate these inconveniences.

I MUST mention likewise, that this Essay bears a particular and very intimate relation to the doctrine concerning the moods of verbs, laid down by the learned author of the treatise on the *Origin and Progress of Language*, (Vol. II.) with which I may presume my hearers to be sufficiently acquainted.

THE account which he gives of the number, the nature, and the import of the moods of verbs, though very acute, and in many respects perfectly just, is certainly very incomplete, and in one important circumstance it is very obscure; which makes me suspect, that, on this point, he had not carried his investigation so far as to obtain a complete and distinct view of the subject which he was treating.

BUT

BUT though I make many remarks on his doctrine, and often refer to it, my Essay is by no means intended to cavil at it, but, on the contrary, to make use of it, as being, on the whole, the best disquisition on the subject that I have seen; to correct what is erroneous, and to supply what is wanting, in his treatise, and to carry the investigation farther than he had done.

I AGREE perfectly with this learned author in thinking that the *infinitive* is most improperly called a *mood*: and I think the observation a very important one; for, on this account, it is to the *infinitive, exclusively*, that we should turn our thoughts, when we endeavour to investigate the general import of the Verb, with a view to ascertain the *accident* which it denotes, and be led, step by step, to form a distinct notion of what is common in the *accidents* of all verbs, and of what is peculiar in the *accidents* of the several classes of them, and thereby be enabled to give good definitions, specifying the essence of a Verb, and the characteristic import of the different classes of verbs, such as substantive, neuter, active intransitive, active transitive, passive, and reflected verbs. The infinitive, I own, does not express the pure general meaning of the verb; for it comprehends likewise the circumstances of time, and in some languages those of person, and of course of number, and perhaps of gender. *Scribere. Scripsisse. Scripturum esse. Scripturas esse.*

BUT the infinitive (so far as I can perceive) denotes no *energy* or modification of thought (such as, affirming, commanding, asking or wishing) that is peculiar to itself, as the other moods do; but only that kind of thought, or combination of thoughts, which is common to all the others. Now, some peculiarity of that kind I take to be the very essence of a mood.

YET the thought expressed by the infinitive is clearly apprehended, and plainly shews that the word denoting it is a verb.

Non est VIVERE sed VALERE vita.

*Sæpe etiam steriles INCENDERE profuit agros,
Atque levem stipulam crepitantibus URERE flammis.*

— *Pudet hæc opprobria nobis*

Et DICI POTUISSE, et non POTUISSE REFELLI.

READING (says BACON) makes a full man, *speaking* a ready man, and *writing* an exact man.

(THESE English words in *ing*, will be called participles, or perhaps verbal nouns; they have the form of *participles* and verbal nouns, but the meaning of infinitives; and may be translated into Greek and Latin by infinitives. But it is of no consequence whether they be called *participles* or *infinitives*; the meaning of them is obvious, and is the same with that of the Latin *infinitives*.)

THE meaning or thoughts expressed by these infinitives, are as plainly characteristic of verbs as those denoted by *Vivo sed non valeo*. *Incendite steriles agros*—*urite levem stipulam*. *Opprobria dicuntur nobis*. Yet in the latter there is *mood*, while in the former there is not. Whence it follows that *mood*, properly so called, is not essential to a verb. It is only the capacity or susceptibility of *mood*, that can with propriety be said to be essential to a verb. This distinction, which I think of some importance, may be sufficiently explained and illustrated by the following examples. It is not division, but divisibility, that is essential to a geometrical line; it is not fluidity, but fusibility, that is essential to lead; not motion, but mobility, nor rest, but the capacity of being at rest, that is essential to body. But *rest* is essential to space, and, for aught I know, *motion* may be so to light.

I SUSPECT therefore some inaccuracy in the learned author's manner of expressing himself, when he says in one page, (161) that moods are essential to verbs, and in the next page remarks that the infinitive is not a mood. This would imply, that a verb, when put in the infinitive, ceased to be a verb; which he does not expressly say, though he comes very near to it, in the following words: "As to the infinitive, I hold it to be no mood, though it be commonly called so; because it expresses no energy of the mind of the speaker, but simply the action" (he should certainly have said more generally the *accident*, as in *esse, valere, or cadere*) "of the verb, with the addition of time. It is therefore used, either as a noun, or it serves to connect the verb with another verb, or a noun, and so is useful in syntax." But still I would ask, When it is used in these or other ways, and is accordingly useful in syntax, does it *bona fide* cease to be a verb? I own I do not think it does; for this reason, that the thought expressed by means of the *infinitive*, may be expressed in synonymous and convertible phrases, in different languages, by means of other parts or moods of the verb. "*To be or not to be*, that is the question," is equivalent in meaning, though superior in simplicity, beauty and force of expression, to "The question is, whether we shall be or shall not be."

— *Nec quicquam tibi prodest*
Aerías TENTASSE domos, animoque rotundum
PERCURRISSE polum, morituro.

Nec quicquam tibi prodest quod aerías domos TENTAVERIS, et animo PERCURRERIS polum.

MOREOVER, it must be taken into consideration, that the infinitive not only appears as the *nomen verbi*, (which some have called it) but expresses fully the *accident* of the verb, whether this be mere existence, or state, or event, or intransitive action, or transitive action, that is, action with relation of various

ous

ous kinds ; and of course it has the proper *regimen* of the verb, when it expresses *action* and *relation*, or, in grammatical language, is transitive ; as in *percurrisse, tentasse, urere, incendere*, in the preceding examples.

Dico, credo, puto, Titium existere, valere, jacere, cecidisse, procubuisse, projecisse Mævium, projectum fuisse a Mævio, have the very same meaning with *Dico, &c. quod Titius existat, quod jaceat, quod ceciderit, procubuerit, projecit Mævium, projectus fuerit a Mævio*.

I CANNOT help thinking, that, in these cases, the infinitives, as well as the subjunctives, are truly verbs, though stripped of that circumstance which is, in strict propriety of language, called *mood*. Nor do the *infinitives* as thus used acquire any further meaning, in addition to the radical import of the verb with tense, like the proper moods ; but the *subjunctives* after *quod* lose their peculiar meaning as *moods*, and signify no more than bare *infinitives*.

I THINK some more illustration may be given to this subject, by considering the import of participles, which partake of the nature both of verbs and of adjectives ; and that of verbal nouns, which partake of the nature and meaning of verbs and of substantive nouns.

IT is an acknowledged fact with respect to participles, and it is equally true with respect to verbal nouns, that, by means of them, various thoughts, commonly expressed by the moods of verbs, or by the infinitives of them, may be expressed with great accuracy, and sometimes with advantage in composition, by enabling us to lessen the number of verbs in a sentence, or to vary occasionally the structure of it. *Nec quicquam tibi prodest morituro tua TENTATIO domuum aeriarum, et cursus tuus circa polum*, though a very crabbed inelegant sentence, has the very same meaning with HORACE's beautiful lines, and with the prose version immediately subjoined to it.

WHY are not *tentatio* and *cursus* reckoned verbs, as well as *tentasse* and *percurrisse* ? They are surely very near akin.

THE

THE answer given to this question by the author of the Essay on the *Origin and Progress of Language*, and which he says is plain, I must own appears to me very obscure and unsatisfactory. Nor can I think that the defect is entirely in me, and that I ought to understand it; for I can specify what is wanting to the answer which he gives, in order to make it plain and satisfactory. His answer is,

“ THAT it (to wit a verbal noun, like *curfus* or *tentatio*) expresses no energy of the mind of the speaker, who pronounces the words; nor does it affirm that the thing exists or does not exist; nor does it command that it should or should not exist; nor does it wish that it may or may not exist; but simply gives us the conception of the mind of the speaker.” Page 167.

BEFORE we can fully understand this answer, (which seems to apply to *infinitives* as well as to *verbal nouns*), or of course judge whether it be just and complete, or not; we must know what the author means by *energy*, and what by *conception*, what more or less he apprehends there is in the one than in the other, or how he distinguishes them. Nor can this be known but by finding what there is in common among all the *energies*, (for something common among them, even as conceived by him, it is demonstrable there *must be*) and not belonging to any simple *conceptions*. We have *energy* expressed, and of course a verb constituted, even according to his definition of a verb, without affirmation, when we wish or command; without command, when we affirm or wish; without wish, when we command or affirm: Yet in all these cases we have equally and indisputably a verb. How shall we know what is in common to them all? How much of the meaning of a verb is in a verbal noun? What is wanting, besides the susceptibility of *mood*? Whence does this susceptibility of mood arise, or wherein does it consist? Does it depend on the combination of the notion of time with that of the proper *accident* of a verb, which combination takes place in the infinitive, and even remains in the participles of a verb, but not in a verbal noun?

Existentialia

Existentia (whether good Latin or not) is the predicament or accident of being.

Vita is the state or accident of living. *Casus*, *obitus*, the events or accidents of falling and of dying.

Cogitatio, *lectio*, *scriptio*, *curfus*, *adificatio*, *trucidatio*, are the accidents or actions of thinking, reading, writing, running, building and murdering.

IN English, almost any noun substantive may occasionally be converted into a verb, by using it to denote those thoughts, or combinations of thoughts, such as existence, state, event, activity, intransitive, or transitive, or reflected, and passiveness or being the object or subject of activity, which are conceived to constitute the essence of a verb.

Water is plainly a noun.

Watered a participle.

To water a verb, without mood.

He watereth, water thou, may it be watered, it was watered, a verb with mood.

A watering, a verbal noun, retaining the accident, but not the import of *mood*; and nearly allied to the infinitive *to water*, in every respect but that it does not involve the notion of time, as the infinitives *to water*, *to have watered*, &c. plainly do.

THESE are but hints. *Valeant quantum valere possint*.

I SUSPECT that the author whose doctrine I am considering, has been rash in limiting the number of *moods* to three; the *indicative*, expressing affirmation, (and of course negation) under which he comprehends the *subjunctive*, as being nearly of the same import, and denoting affirmation, only qualified or conditional; the *optative*, expressing wishing or praying; and the *imperative*, expressing command.

I SHOULD think the same kind of reasons that he urges against admitting an *interrogative* mood, namely, that "it is not expressed by any different form of the verb, but only by particles, or by a certain arrangement of the words,"
and

and for rejecting the *potential* mood, and for making the *subjunctive* only a branch of the *indicative*, would apply with equal force against admitting an *optative* mood, at least in some languages, as for instance in our own.

IN the following lines,

Te SPECTEM suprema mihi cum venerit hora;

Te TENEAM moriens deficiente manu.

The verbs *spectem* and *teneam* express very clearly the *energy* of wishing. This modification of thought is denoted in Latin by inflection, and would be so in Greek, σε θεῶμαι, σε κατέχομαι, and will be allowed to constitute a perfect mood. But in English it must be denoted by a certain arrangement of the words, and therefore should be no mood, any more than interrogation. “Thee “ may I look on when my last hour shall come; thee may I “ grasp, when dying, in my failing hand.” *I may look on thee, I may grasp thee*, have meanings as different from those denoted by the same words differently arranged, as *Cæsar was killed*, is from *was Cæsar killed?*

IF I am rightly informed, the Chinese language has no *imperative mood*; and those who speak it are obliged to employ a very clumsy circumlocution, by means of a verb signifying *command*, to express the familiar meaning of our imperative.

IT does not appear clearly to me, that the *subjunctive* mood expresses merely qualified or conditional affirmation in every case, though undoubtedly it does so in many cases. In the following lines of HORACE,

Ulla si juris tibi pejerati

Pœna, BARINE, NOCUISSET unquam;

Dente si nigro FIERES, vel uno

Turpior ungui,

CREDEREM.

The word *crederem* to be sure denotes merely a qualified or conditional affirmation : I might, could, would, or should believe, if a certain event took place. But the verbs expressing this condition and supposition, are also in the *subjunctive*, *nocuisset*, *fieres*, after the particle *si*. With this particle, they might have been put in the *indicative*, and the sense would still have been complete, *nocuerat*, *fiebas*. The same thought may be expressed accurately in English, without the use of any particle corresponding to *si*, and merely by the peculiar arrangement of the words, just as was done with the wish of TIBULLUS, “ Had
“ any punishment ever overtaken you for your broken vows ;
“ were but one of your teeth growing black, or even were but
“ one of your nails becoming less beautiful, I should believe
“ you.”

I CANNOT conceive that the three first verbs in this sentence denote any affirmation at all, conditional or unconditional, but a very plain supposition. And this thought seems to me to be as well entitled to be called an *energy*, as TIBULLUS's wish ; and when it is expressed (no matter in what way, whether by inflection, by augment, or by peculiar arrangement) by a verb, it must be either a perfect grammatical mood, or something very near akin to one.

THE very same kind of thought, to wit supposition, is expressed by *circumlocution*, and a kind of *metaphor*, in the following lines.

PONE me, *pigris ubi nulla campis*

Arbor æstiva recreatur aura :

PONE *sub curru nimium propinqui*

Solis, in terra domibus negata.

IN which *pone*, though in the *imperative* mood, expresses no command, but only supposition or condition. This *Captain Macbeath* and *Polly Peachum* (or Mr GAY for them) understood perfectly ;

perfectly; and accordingly translate the thought very well, without either an *imperative* or a *particle*, by *arrangement*.

*Were I laid on Greenland's coast,
Were I fold on India's soil.*

It may be remarked too, that HORACE expresses his qualified or conditional affirmation, which is subjoined to the supposition by a verb in the indicative, not in the subjunctive mood.

Dulce ridentem LALAGEN AMABO.

Macheath takes the common *subjunctive* :

Too soon the half year's night WOULD pass;

And Polly, the *potential*,

I COULD mock the sultry toil.

— *Omnia novit*

Græculus efuriens; in cælum, JUSSERIS, IBIT.

A little hungry Greek knows every thing; he will go to heaven, *should you desire him*. This is *conditional affirmation*, expressed by the *indicative*, and *supposition* by the *subjunctive* mood.

*Illum et parentis CREDIDERIM sui
Fregisse cervicem.*

I *could believe* that he had murdered his father. This I conceive to be an instance of the *potential mood*; if not of the verb *credo*, at least of human thought.

WHATEVER may be thought of the preceding observations, it must at least be admitted, that the moods of verbs may be considered in two very different points of view ; either *with relation to any particular language*, or *with relation to human thought*, which must be supposed the same in all ages and nations. For the sake of distinctness, I shall call the expressions of them, by inflection or otherwise in language, *grammatical moods*; and the thoughts, or combinations of thoughts, so expressed, as well as similar combinations of thoughts, though not always, or perhaps never expressed in the same way, I shall call *energies*, or *modifications*, or *moods of thought*.

WITH respect to the former of these things in any particular language, there can be no dispute or difficulty. Any tolerably good grammar of that language will shew at once the number and the forms of them in it ; and the exact import of each of them, and the proper application of them all, will soon be learned by attending to the use of those who speak and write that language well. But the latter (the moods of thought) must be investigated in a different and much more laborious way ; by strict attention to our own thoughts, and with such aid as the structure of language, and observation, and even experiment afford.

ALL languages, I believe, are very defective in respect of that variety and accuracy of combination and of distinction, which we know with infallible certainty take place in thought. Nor do I know of any particular in which language is more deficient, than in the expressing of those *energies* or modifications of thought, some of which always are, and all of which might be expressed by the grammatical moods of verbs. Of this, there cannot be a clearer proof, than the well known facts, that we are obliged to express by the same mood very different modifications or *energies* of thought, and that the number of moods, as marked by inflection or otherwise, is different in different languages, which, of course, do not correspond so far

as to admit of perfect and literal translation in all cases from one to another, or at least not without circumlocution.

YET, unfavourable as this circumstance must, at first sight, appear to the hopes of one who wishes to investigate the nature of the moods of verbs, and ultimately to ascertain the nature of a verb itself, I think it is chiefly by attending to it, by considering what modifications of thought are expressed by grammatical *moods* in different languages, and by comparing them with such modifications of thought as are never, or at least not usually, expressed in that way, and by examining how it comes to pass that some of them are, while others are not so expressed, that we shall be led to discover wherein they agree or differ, that is, to learn the common nature of all, and the particular nature of each of them, which is the immediate object of enquiry.

THE province of the schoolmaster who undertakes to teach any particular language, English, French, Latin, or Greek, extends no farther than to explain the meaning and shew the use of the grammatical moods which are found in that language which he teaches; and his scholars, at least at an early period of life, can go no farther.

BUT the province of the philologist, who wishes to examine the structure of language, and of the philosopher, who wishes to investigate the laws of human thought, is much more extensive. Every grammatical *mood* that is found in any one language, is to him a proof of a corresponding distinction, or variety of *energy*, or modification of thought; for all men are by nature capable of learning any language. Nor does he stop here. From considering how many *energies* are expressed by grammatical *moods*, he is led to form a more extensive and just notion of those *energies*, and may naturally suspect, and with a little attention will soon discover, that there are many other similar *energies*, which are not expressed in any language; and to these, as well as to those that are expressed, in some or
all

all languages, by grammatical moods, he ought unquestionably to direct his attention.

It is evident at first sight, that a variety of thoughts, or modifications of thought, may be combined, or conceived and expressed, along with the general meaning or *accident* denoted by any verb.

It is equally evident, that only a few of these modifications of thought are expressed by grammatical moods in Greek, Latin or in the modern European languages.

It is also evident, that in these languages, one grammatical mood is often employed to denote very different modifications of, or additions to, the thought, or combination of thoughts, which is expressed equally by every part of the verb, and which may be found without *mood*, though not without *tense*, in the *infinitive*.

AND it is plain also, that both those additions and modifications of thought, which commonly are, and those which are not expressed by the grammatical moods of any verb, may be expressed by the infinitive of that verb, with the addition and *regimen* (that is, *marked relation*) of another verb. And this additional or auxiliary verb must be in the first person, either singular or plural, of the present tense of the indicative mood. In some cases, there may be more than one step in this process of resolution, as in interrogation; but it always terminates ultimately in a verb in the present of the indicative, and in the *first person*, as the phrase to be resolved is the expression of the thought of the person or persons speaking.

AFFIRMING, denying, testifying, foretelling or prophesying, asking, answering, wishing, hoping, expecting, believing, knowing, doubting, supposing, stipulating, being able, commanding, praying, requesting, supplicating, loving, hating, fearing, despairing, being accustomed, wondering, admiring, warning, swearing, advising, refusing, exhorting, dissuading, encouraging, promising, threatening, and perhaps numberless other modifications

cations of thought, for which I cannot easily find names, all admit very readily of being combined with the general import of a verb, and form with it various more complicated meanings, which are easily distinguishable from one another, and are not convertible, and therefore must be different. There are various degrees and kinds of resemblance or affinity among them, in consequence of which they admit of being arranged, and of course of having different more general names given with propriety to the several divisions or classes of them. And there is something common among them all, to which the name of *energy*, without any impropriety (that I can see), may be applied. If every one of them had been expressed in all languages, by variations as striking as those of *τυπτω*, *τυπτοιμι*, and *τυπτε*, they *must* have been acknowledged as distinct *moods* of the verb. They are equally *moods* or *distinct energies* of thought, whether expressed in language or not, if they be but understood by those who use language; as for instance, in the case of the grammatical mood called the *imperative*, by which we express occasionally prayer to GOD, command to a slave, request to a superior, advice to an equal or to any one, order as from an officer to his subaltern, supplication to one whom we cannot resist. These *specific* differences of thought were perhaps in some measure expressed in Greek by the *tenses* of the imperative, the exact uses and import of which I must own I understand but very imperfectly.

If they could all be arranged under three heads, as the author of the *Origin and Progress of Language* conceives, affirming, wishing and commanding; or if they could all be referred to one head, affirmation, as many philologists think they may, this would be but a small addition to our knowledge concerning them, compared to what we might expect to obtain by a more accurate examination of them; and it must be acknowledged to be somewhat rash to attempt to arrange them, without first examining them carefully.

THE case of the *moods* of verbs is exactly parallel to that of their *tenses*, which is very accurately pointed out and happily illustrated by the learned author of the treatise on the *Origin and Progress of Language*.

ALMOST every language has its own advantages and disadvantages in the expressing of the various divisions and relations of time ; but the conception of these divisions and relations of time must be the same in all mankind. So it is with the conception and the expression of *moods* or *energies*, and indeed with the conception of every thing else which can be expressed by verbs, or by any other words. As in one of his own instances: " The LORD gave, and the LORD hath taken away; blessed be the name of the LORD." There is a precision and a beauty in this use of the simple contrasted with the compound past tense, which cannot be attained in Latin. *Dominus DEDIT, et Dominus ABSTULIT; benedictum sit nomen Domini.* But it might be attained in Greek, by using the aorist for *gave*, and the preterperfect for *hath taken away*. On looking into the Septuagint, I do not, however, find that this delicacy of expression has been attempted. But the genius of the Greek language has led the translators to another nicety and propriety of expression, which cannot be attained in any other language, nor indeed explained without a circumlocution: 'Ο Κυριος ἔδωκεν, ὁ Κυριος ἀφείλατο' ἐν τῷ ὀνόματι Κυρίου ἐνλογημενον. In this passage, ἔδωκεν is the aorist of the active voice of the verb signifying *to give*; ἀφείλατο is the aorist of the middle voice of the verb signifying *to take away*. The Greek sentence therefore expresses, The LORD gave, the LORD took away *to himself*, took back to himself, or simply *took back*. *Dominus DEDIT, Dominus RECEPIT.* If the Greek verb ἀφαιρῶ had a preterperfect middle, and if this tense of the middle voice had, like most other parts of the middle verb, a kind of reciprocal or reflected meaning, on which points I dare not presume to decide, but must leave them to the judgment of grammarians, it would be possible to express in Greek both
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the niceties in question. Yet it cannot be doubted, that all mankind are capable of understanding them perfectly, whether they use a language in which they can be expressed by mere inflections or not.

By means of the same *tense* and the same *mood*, to wit, the future of the indicative, we are accustomed to express either mere futurity, and of course a prophecy, or an intention or purpose, or a threat, or a promise.

— *Improvisa Lethi*

Vis rapuit RAPIETQUE gentes. HOR.

*Quo nos cunque FERET melior fortuna parente,
IBIMUS O socii comitesque.* HOR.

Cras ingens ITERABIMUS æquor. HOR.

*Ille Deum vitam ACCIPIET, Divisque VIDEBIT
Permissos Heroas, et ipse VIDEBITUR illis :
Pacatumque REGET patriis virtutibus orbem.* VIRG.

Verberibus casum te in pistrinum Dave DEDAM usque ad necem.
TER.

*Quarum, quæ forma pulcherrima, Deiopeiam
Connubio JUNGAM stabili, propriamque DICABO.* VIRG.

IN the two first of these instances from HORACE, we have, I think, the bare expression of what is to come to pass.

IN the third and fourth, we have not only futurity, but intention or purpose, plainly expressed.

THE prophecies in the four instances, from VIRGIL's *Pollio*, are, I apprehend, something more than what is expressed or understood in the two first of the preceding examples, and dif-

ferent from what is expressed in the two last of them. The future events mentioned seem to be announced with authority, or something like supernatural knowledge or information, which I take to be essential to the notion of prophecy.

BUT *Juno's* promise of a handsome wife to *Æolus*, and *Simo's* threatening of a severe whipping and perpetual imprisonment and hard labour to *Davus*, are by no means mere predictions of such good or evil to them, nor yet bare enunciations of the intentions of the speakers to them, but something very different; other *energies*, modifications of thought, or moods, in so far at least as mood is predicable of thought, which I think it is completely. For if there were two or ten different forms or inflections of a verb in any language, or in all languages, to express any one *mood* of thought, for instance affirmation, wish, or command, they would not be different *moods*, but only different forms of the same *mood*. This is not altogether an imaginary case. In English we have, at least in some parts of our verbs, two forms or grammatical moods for one mood of thought; one of them simple, and only marked by inflection of the primary verb; the other compound, consisting of an auxiliary in addition to the primary verb; and in this case the inflection is in the auxiliary verb alone. *I write. I do write. They wrote. They did write.* (*They did wrote or they do wrote*, would be solecisms.) *Write thou. Do thou write.* Every person, I think, must acknowledge, that these are not instances of two indicative and of two imperative moods in English, but only two forms or expressions of one indicative and of one imperative mood. If so, then it follows that *mood* is generally conceived to be properly an attribute or predicate of thought alone, while only the expression of it, by inflection or otherwise, belongs to grammatical verbs, just as the first and second future, or the first and second aorist, of the regular Greek verbs, are not two futures and two past tenses, but only two different forms or expressions of one future and of one past tense,

which

which tenses are uniformly understood by all mankind. While the present, the imperfect, the aorist, the perfect, the plusquamperfect, and the future, are really different *tenses*, or expressions of different notions of the relation of the general import of the verb to time; which expressions and notions are by no means convertible, and certainly may be understood by all mankind, though they are not found distinguished in all languages. In short, we must draw no inference with respect to the nature, the number, the affinities, or the arrangements of the moods of verbs, from the inflections or other variations employed in language, without taking into consideration also the relation which those inflections bear to human thought.

I HAVE further to add to these remarks on the import of the *moods* of verbs, that such is the affinity or mutual relation among them, that they may often, by circumlocution, and the introduction of an additional verb, and sometimes without any such addition to the principal verb, and merely by a kind of metaphor, be interchanged, or substituted one for another, without materially affecting the sense of the passages wherein they occur, and sometimes with the manifest effect of giving a more full and particular exposition of the meaning of such passages. This I mention, not for the sake of any advantage that can in general be obtained by such interchange, or substitution, but that I may point out that it is not properly a resolution or decomposition of the meaning of the several moods, as some philologists have supposed, and have thought an important discovery in grammar, but a mere circumlocution, and a kind of paraphrase of the shorter and more common expression, and sometimes a mere metaphor, instead of a literal expression of thought. That it can be no resolution of a more complicated into several simpler meanings, appears plainly from this consideration, that it is *mutual* among the moods; the supposed simpler being as easily resolvable into the supposed complicated, as these are into them. But of this afterwards. In general,

the expression by the common, or what we may call the natural mood, is as clear and intelligible as the circumlocution, or supposed resolution of it, and much shorter, and more animated and forcible, and of course more agreeable and proper.

It must be owned, however, that sometimes there is a great and manifest beauty and advantage, not only in point of variety, but in force and animation of expression, obtained by using a mood of the verb, and a form of speech different from what might be termed the natural one, and what would express the literal meaning of the speaker. Thus, in the ode of HORACE, already quoted, the use of the *imperative mood* instead of the *subjunctive*, which would express the literal meaning, appears to me advantageous, even putting all regard to verse out of the question. PONE *me pigris*, &c. PONE *sub curru*, &c. is surely more forcible and animated than *Si ponerer*, or *Si effem positus*, or simply *positus*, though the general meaning be the same. And GAY's lines, in imitation of these two stanzas of HORACE,

*Were I laid on Greenland's coast,
Were I fold on India's soil,*

though highly beautiful, and in one respect, I mean the boldness of the imagery introduced, superior both to HORACE's own lines, and to those of his translator, are less animated than either the original or the translation,

PLACE ME *where never summer breeze
Unbinds the earth or fans the trees;
PLACE ME beneath the burning ray,
Where rolls the rapid car of day.*

All such applications of the imperative mood I consider as metaphorical; understanding by the term metaphor, the *transferring*

ferring of any word or phrase, and employing it to express a thought different from what it denotes in its original, strict, and literal signification; which I take to be the very essence and proper definition of this figure of speech.

IN like manner, the *interrogative mood*, instead of the *conditional* or *subjunctive*, which would fully and clearly have expressed the literal meaning of the poet, gives peculiar animation and spirit to the following lines:

*Fervet avaritia miseroque cupidine pectus ?
Laudis amore tumes ?*

Are you a covetous wretch ? Are you a coxcomb ?—If you are a miser, If you are a coxcomb, would surely be flat.

AND, on the same principle, such expressions as the following, *Shall we receive good at the hand of GOD, and shall we not also receive evil ?—Shall I do this great evil, and sin against GOD ?* are more animated and forcible than the plain literal expressions of the same thoughts would be.

IT is more remarkable, that sometimes a kind of beauty and force, not indeed from greater animation, for simple command and interrogation, as expressed by the imperative and interrogative moods, are, I believe, the most animated enunciations of thought, but from greater solemnity, may be given by employing the *indicative mood*, where either the *imperative* or the *interrogative* would fully have expressed the speaker's meaning.

*Lydia DIC per omneis
Te deos ORO, Sybarin cur PROPERES amando
Perdere : cur, &c.*

THEN follow all the articles of interrogation. The general meaning would have been completely expressed without the *imperative DIC*, and the *indicative ORO* ; yet I presume no person
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of taste and judgment will dispute, that, independently of the versification, there is a beauty and force in HORACE's expression far beyond what there would be in the simple interrogation, *Lydia cur Sybarin properas amando perdere?*

THE future of the *indicative* is employed in some cases wherein the *imperative* mood would express the literal meaning of the speaker; as for instance, in the Decalogue, the expressions, *Thou shalt not kill, Thou shalt not steal, Thou shalt not commit adultery*, have not the proper future meaning, but are the most absolute commands, or rather prohibitions, much more forcible, because more solemn, than *Kill not, Steal not, &c.*

THE preceding observations on the nature and import of the moods of verbs, are so imperfect and so desultory, that it may appear very rash to draw any formal inferences from them. I hope, however, they are so far at least intelligible and just, that the conclusions which I have in view, and which I think might be fairly deduced from a more ample and more methodical collection of similar observations, will neither appear absurd nor paradoxical.

THEY are chiefly the following.

I. THAT the *energies*, or modifications of thought, expressed by the moods of verbs, are such as may be expressed separately by other verbs, and chiefly by *active* verbs; or, in the phraseology of the author of the essay on the *Origin and Progress of Language*, That the *energies* of the mind of the speaker, denoted by the moods of verbs, are truly *accidents*, and chiefly *actions*.

THIS perhaps the learned author was not fully aware of, else he would not have used, in his definition of a verb, a phrase which may be fairly translated, "A verb is a word chiefly significant of being and of action, of the action of the mind of the speaker relative to that action," &c. Or, if he had been aware of this, he must, I think, have been led to examine
more

more accurately the nature of the energies, actions, or accidents denoted by the moods of verbs.

YET, from his uniformly employing the term *energy* to denote the general import of all moods, we may presume, that he had some conception of that intimate relation between the import of the accidents of some and that of the moods of all verbs. For he must have known, that *energy*, though a compound Greek word, and *action*, though a simple Latin word, when applied to the operations of mind, are perfectly synonymous; and he very properly mentions *action* as one of the chief accidents denoted by verbs.

HIS definition might even be fairly stated thus. "A verb" is a word chiefly significant of accident, of the accident of "the mind of the speaker relative to that accident," &c. For this is only substituting the *generic* term *accident* for the *specific* term *energy* or *action*; so that the proposition, though less particular and accurate, would still be true.

II. THAT the *energies* expressed by the moods of verbs are chiefly the *social* operations of mind, as they have been very properly termed by Dr REID; that is to say, such as imply the belief of some other intelligent being to whom they relate, and which cannot be supposed to take place in a solitary being.

III. THAT the grammatical moods of verbs are concise modes of expressing some of those combinations of thoughts, which occur most frequently, and are most important and striking.

IV. THAT the number of grammatical moods is limited by the same circumstances which seem to limit the variety, precision, and perfection of language, in other respects; and particularly by the convenience of those who use it, and who in general will have no more moods to their verbs, and no more words or inflections of any kind, than they have absolute occasion.

caſion for ; and, of courſe, muſt often employ one mood as they do one word, or one inflection, in various ſenſes, that is, to expreſs occaſionally different thoughts.

V. THAT grammatical moods contribute greatly to the beauty and perfection of language, by the brevity, animation, and force, which they give to the expreſſion of our moſt familiar and intereſting combinations of thoughts, which may indeed be expreſſed, in ſome meaſure, by circumlocution, and the uſe of additional verbs, but not with the ſame advantages.

VI. THAT grammatical moods of verbs, like other inflections of words, expreſs much better than any ſucceſſion of words can do, the intimate connection and relation of various thoughts, which are not ſucceſſive, but ſimultaneous or coexiſtent, and which appear unnaturally diſjointed, and in ſome meaſure altered, when they are expreſſed by a ſeries of words denoting each of them ſeparately and in ſucceſſion.

SOME of theſe concluſions, eſpecially the third, the fifth and the ſixth, are ſo intimately connected, that it is difficult to conſider them ſeparately ; and as it is of no conſequence to keep them quite diſtinct in the following illuſtrations, I ſhall conſider them pretty much together, as I conceive they tend to explain and illuſtrate one another.

I. THE firſt of thoſe concluſions can hardly be thought a novelty, if it be conſidered that ſeveral philologiſts have maintained, that ſome of the moods are *reſolvable* into ſuch circuitous expreſſions, by means of other additional verbs. In truth, they are all, in ſome meaſure, *convertible*, though, in ſtrict propriety of language, not *reſolvable*, nor even *perfectly* convertible, in that way.

THE *indicative*, which denotes affirmation, is nearly the ſame in meaning, and of courſe is nearly convertible, with a verb
of

of affirming in the *first person* (either singular or plural) of the *present* of the *indicative*, and the general import of the primary verb, without mood, that is, in the infinitive. *Titius scribit, dico, dicimus, Titium scribere, quod Titius scribat. I say, we say, that he writes.* This kind of expression is a mere pleonasm. But something very nearly approaching to it is often used in very solemn language, as in that of the Holy Scripture, and with a good effect. *Verily I say unto thee, &c.*

THE *imperative mood* is in some measure convertible with a verb of commanding, such as *Jubeo*, in the first person of the present of the indicative, and the primary verb without mood.

I nunc, et versus tecum meditare canoros.

Jubeo te nunc ire et tecum meditari, &c.

Jubeo, dico me jubere.

IN like manner, the *optative mood* is, in some measure, resolvable or convertible by means of the primary verb without mood, and a verb of wishing, such as *opto* or *cupio*, in the first person of the present of the indicative. *Te teneam, te spectem. Opto, cupio te tenere, te spectare.* It has been found unnecessary, but it would undoubtedly be possible, and on some occasions might be useful, to have grammatical moods, either by inflection or by arrangement, (like *may I hold, may I see*) to denote *spero te tenere, despero te tenere, confido te tenere, or te spectaturum.*

THE *interrogative mood* is not resolvable exactly in the same way, by the primary verb without mood, and the *indicative* of another verb: there is another step in it; and, after all, the resolution is still less perfect than in the other moods.

Quid faciam? Moriar? et Amyntam perdet Amyntas?

The meaning here is more than merely, *Cupio scire quid facturum sim, utrum moriar necne, num Amyntas semet perditurus sit. Even Rogo, Jubeo, aliquem, mihi dicere quid faciam, quid debuero*

facere, &c. does not fully express it. The *energy* of interrogation, in point of thought, admits of a more close and perfect combination with the conception denoted by a verb, than can well be expressed by any circumlocution*; but it is fully denoted by the interrogative mood, as appears by the person who is addressed in that mood returning a pertinent answer. This, which is so manifest with respect to the interrogative mood, is equally true with respect to all the other moods.

WONDER has a *kind of mood* appropriated to the expressing of it, made out by the addition of a particle, originally of interrogative meaning, to the indicative mood; at least, I think it is so in all the languages that I am acquainted with.

Quam timeo quorsum evadas. TER.

*Quam penè furvæ regna Proserpinæ,
Et judicantem vidimus Æacum.* HOR.

Tela quam certo moderatur arcu. SEN.

Qu'il est cruel—qu'il est doux d'être Pere!
DIDEROT Pere de Famille.

How fearful and dizzy 'tis to cast one's eyes so low!

*How many thousands of my poorest subjects are at this hour
asleep!* SHAKES.

NONE of these sentences are interrogations, or can admit of an answer. They all express (in addition to the general meaning

* I BELIEVE the nearest we can come to it is by the use of the imperative of a verb of affirming with the infinitive of the primary verb.

*Dic mihi Damata cujus pecus, an Melibæi?
Cujus est pecus? Dic cujus pecus est.
Jubeo te mihi dicere cujus pecus est.*

ing of the primary verbs) the emotion of wonder, or some mixed emotion, of which wonder forms a part. No person can doubt that this *energy* might have been expressed by inflection of the verb; and that, if it had been so, such inflection *must* have been reckoned a perfect grammatical mood, and might have been resolved, though no doubt but imperfectly, into a sentence containing the primary verb, (*timeo, video, &c.*) and some verb, or phrase containing a verb, expressive of wonder, or some similar emotion. *Miror me tam pene vidisse regna Proserpinæ, miror quantum timeo, mirus est timor meus, quorsum evadas.* I wonder, tremble, shudder, to cast my eyes so low. I admire, it is admirable, that many of my subjects are at this hour asleep.

WITH respect to the *grammatical mood* called the *subjunctive*, it must be observed, that it (like many words in common language) has different meanings, or expresses different *energies*, combined with the radical meaning of the verb, such as, wish, (already considered) supposition, power, condition, &c. It must be in vain, therefore, to look for any one verb, or any one thought or energy, by means of which the subjunctive mood may uniformly be resolved, as the indicative may be by *dico*, the optative by *opto*, the interrogative by *rogo*, the imperative by *jubeo*. It is to be resolved occasionally by means of different verbs, according to the particular energy or mood of thought expressed in any instance. Of this indeed there can be no better proof than the number of different auxiliary words which we employ in English to make out what we call the subjunctive mood in all its *tenses*, such as, *may, can, might, could, would, should*, which are, by no means, synonymous and convertible terms, even in this application of them, and yet all correspond occasionally to the Latin subjunctive mood, which is simple, and only marked by inflection.

Crediderim, possum credere, I might believe; *credidissim, potui credere*, I might have believed. Condition, stipulation, suppo-

sition, which, though somewhat different, are very near akin, are among the most frequent meanings of the subjunctive mood. This meaning, or mood of thought, may be resolved, to a certain degree, into an imperative mood (the resolution of which hath already been shewn) and the primary verb. An ingenious etymologist* has shewn, that the Greek particle *ei*, and the Roman *si*, are but contractions of certain parts or inflections of the substantive verbs, *ειμι* and *sum*; which parts of those verbs have an imperative meaning, *Be it so*. The same author shews, that our English particle *if* is just a contraction of the imperative of the verb *give*, anciently written and pronounced *gif*. *Si vis me flere. Sit, esto, quod vis, or velis me flere. Fac, pone, te velle me flere*. The imperative *fac* was often used by the ancient writers of Latin in this sense; *pone* seldom by them, but often by modern writers; *τιθει* was used in the same sense by the Greeks. Indeed, different parts, both of *τιθημι* and of *pono*, were used for this purpose; the Romans, I presume, imitating the Greeks. It is worthy of observation, that in French, the use of the conditional particle *si* supercedes completely the use, either of the subjunctive or of the conditional mood. *Si* in French always governs the indicative mood. *Si je peux, si je pouvois, si je pourrai*; never *Si je puisse, si je pussé*, in the *subjunctive*, nor even *si je pourrois* in the *conditional mood*.

As to the circumstance of being subjoined to a preceding member of a sentence, and commonly to a verb in the indicative mood, from which the subjunctive has got its name, the difference of meaning between the subjunctive so employed, and that of the indicative in some cases, and between it and the bare infinitive in others, is so minute, that it is difficult to ascertain it, and perhaps impossible to express it in words. Accordingly, we often find, that in translating from one language into another, those three grammatical moods *may* and perhaps

* MR HORNE TOOKE.

perhaps *must* be interchanged, to preserve the original meaning, without violating the idiom of the language into which the translation is made. But the use of a peculiar inflection or mood to distinguish the secondary or subjoined verb from the fundamental or primary verb in a sentence, often has its use; and I think, without much refinement, we must perceive an elegance, and perhaps too a greater degree of precision, in those languages in which this nicety is attended to, as in Latin and in French; for in our own it is almost lost sight of. But it must be observed, that it is not every verb subjoined to another by the relative pronoun *qui*, that is put in the subjunctive mood. In many cases, either the indicative or the subjunctive may be employed, almost indiscriminately, both in Latin and in French. But sometimes the one, sometimes the other, ought to be used. Where the affirmation is certain and positive, the indicative should be subjoined to the indicative.

— *Heu quoties fidem,*
Mutatoſque deos FLEBIT : et aſpera
Nigris æquora ventis
EMIRABITUR inſolens,
QUI nunc te FRUITUR credulus aurea :
QUI ſemper vacuum, ſemper amabilem
SPERAT; neſcius auræ
Fallacis : miſeri, QUIBUS
Intentata NITES.

Cependant jè RENDS grace au zele officieux,
QUI ſur tous mes perils vous FAIT ouvrir les yeux.

Jeune et vaillant heros, DONT la haute ſageſſe
N'EST point le fruit tardif d'une lente vieilleſſe.

Though in theſe lines of BOILEAU, there be no verb but *eſt*, it is plainly ſubjoined to the preceding member of the ſentence

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tence by means of the relative *dont*. *Ne soit point le fruit*, would, in the first place, be bad French, and, in the next place, would have been a very impertinent insinuation to LOUIS XIV. as if his high wisdom had been somehow contingent, or hypothetical. But BOILEAU was not a man likely to fall into either of these errors.

ON the same principle, I presume, the indicative mood is subjoined to the indicative, in the following passage of the Holy Scripture: *Je suis l'Eternel ton Dieu, qui t' AI tiré du pais d'Egypte, de la maison de servitude*. The subjunctive mood, *Qui t' AYE tiré*, would manifestly be inelegant and inaccurate in this place, where the subjoined affirmation is positive and certain. And for the same reason, we should never hesitate to express the same thought in Latin by the words, *Ego sum Dominus tuus Deus, qui EDUXI te e terra Ægypti, e domo servitutis*; and should be sensible of a gross impropriety, if the word *eduxerim* were substituted for *eduxi*.

BUT in innumerable instances, wherein the subjoined verb expresses any thing uncertain, precarious, contingent, or dependent on the will or power of another, it is put in the subjunctive mood: hence this mood has, in all its *tenses*, a sort of affinity or relation to a *future* meaning. Still, however, great latitude is allowed to writers, both in prose and verse, and is actually taken by the best of them, in the use of the indicative and of the subjunctive moods; as in the following instances from VIRGIL and CICERO.

QUID FACIAT *letas segetes*, QUO SIDERE *terram*
Vertere, Mæcenas, *ulmisque adjungere vites*
 CONVENIAT: QUÆ CURA *Boum*, QUI CULTUS *habendo*
SIT pecori, apibus quanta experientia parcis,
Hinc canere incipiam.

Vos,

— Vos, O clarissima mundi

*Lumina, labentem cælo QUÆ DUCITIS annum,
Liber, et alma Ceres; vestro si munere Tellus
Cbaoniam pingui glandem MUTAVIT arista,
Poculaque inventis Acheloia MISCUIT uvis :
Munera vestra cano. Tuque O CUI prima frementem
FUDIT equum magno tellus percussa tridenti,
Neptune: et cultor nemorum CUI pinguis Cee
Ter centum nivei TONDENT dumeta juvenci.*

*Enumerare possum QUÆ SIT in figuris animantium, et quam sô-
ters subtilisque descriptio partium, quamque admirabilis fabrica
membrorum. Omnia enim QUÆ quidem intus inclusa SUNT ita nata,
atque ita locata sunt, UT nihil eorum supervacaneum SIT, nihil ad
vitam retinendam non necessarium.*

*CUJUS quidem administratio nihil HABET in se QUOD reprehendi
POTEST; ex iis enim naturis QUÆ ERANT, QUOD effici POTUIT
optimum effectum est: doceat ergo aliquis potuisse melius: sed nemo
unquam docebit: et SIQUIS corrigere aliquid VOLET, aut deterius
faciet, aut id, quod fieri not. POTEST, desiderabit.*

IN these passages, the subjoined verbs are marked in capitals. They are to the number of seventeen; yet of them no less than twelve are put in the indicative mood. And it may be observed, at least with respect to the two passages from CICCERO, that the meaning expressed by the subjoined indicative is not distinguishable, in several cases, from that which, in other cases, is expressed by the subjunctive mood.

THESE more particular observations, and the well known general fact, that, in our own language, we find means to dispense with the use of a peculiar grammatical mood, to denote barely the circumstance of being subjoined, I apprehend coincide perfectly with the account given of the comprehensive and various meanings of that grammatical mood which is
called

called the subjunctive, and amount to a full confirmation of that account.

II. THE second of those conclusions can scarce require any explanation or commentary. The modification or mood of thought, which is most commonly expressed by a grammatical mood of a verb, is unquestionably that of affirmation, under which we may comprehend negation, or else we must use the more general term *proposition*, which comprehends them both. This is expressed by the indicative mood. Next to this, the moods of thought, most commonly expressed by verbs, are those of command and of interrogation; the latter (at least in all the languages that I know any thing of) being *usually* expressed, either by the addition of some particle to the common indicative mood, or else by some peculiar arrangement of the words connected with a verb in that mood. *Vidisti, Thou sawest* or *thou didst see. Vidistine? Sawest thou, or Didst thou see?* Sometimes, however, it is not expressed in either of these ways, nor in any way but merely by the tone of voice of the speaker; and consequently, when it is written, and read silently, it cannot be distinguished from a proposition. *Fervet avaritia pectus. Laudis amore tumes.* Hence the use of points or marks of interrogation in writing. The former (command) is commonly expressed by a distinct grammatical mood.

THESE three moods are all plainly social modifications of thought. No man could be supposed even to *form* (not to say *utter*) a proposition, a question, or a command, who did not believe that there were other intelligent Beings besides himself, who might understand him. In general too, (for I admit there may be exceptions to this) the person who utters a proposition wishes to be believed, he who gives a command wishes to be obeyed, he who puts a question wishes to be answered, and all of them wish to be understood. These are all operations of thought,

thought, which cannot be supposed to take place in a solitary Being.

BUT there are some moods of thought denoted by the grammatical moods of verbs, (more or less perfectly) which are not, strictly speaking, social acts of the mind; for instance, wishing, supposing, wondering. These may all be supposed to take place in a solitary being, like ROBINSON CRUSOE in his island, as well as in CICERO in the Forum of Rome.

THE greatest part, even of common conversation, consists of *propositions*; and whole volumes, both in history and in science, may be, and perhaps have been written, consisting entirely of propositions, and of course requiring no other mood but the indicative.

BUT in common conversation, and still more remarkably in all bustling and interesting scenes, commands and questions must occur, and, of course, the interrogative and imperative moods, however formed and marked, become necessary.

NEXT to these purely social acts of the mind, or possibly not less frequent or important even than them, is the familiar and interesting emotion of wishing. And this emotion or energy of thought we often have occasion to express or communicate to those among whom we live and with whom we converse; so that although it be not of itself, strictly speaking, a social act of the mind, yet it is plainly very near akin to one, and may almost be said to become one when combined with that of affirmation, as it is when expressed by the optative mood in common discourse; for it would not be so in soliloquy. Now, these are the modifications of thought, which, in most languages that are tolerably perfect, are expressed by grammatical moods in one way or another.

III. THE third conclusion, " That the grammatical moods
 " of verbs are concise modes of expressing the most frequent
 " modifications of thought, (and the most important or in-
 VOL. II. F f " tereesting

“ interesting of them)” is self-evident, when we compare them with the circumlocutions into which it is thought they may be resolved. But it will be illustrated more fully than is necessary here, in considering the two last conclusions.

IV. As to the fourth conclusion, it must be very plain to us all, from the experience we have had of different languages, that none of them are in every respect, nay hardly in any respect, absolutely perfect; and corresponding, either by the variety of words which they afford, or by the modifications, inflections, and arrangements of those words, to all the varieties and niceties of human thought. It is only the most common and familiar thoughts or notions that have particular words in all common languages to denote them, and only the familiar and frequent combinations of thoughts that have appropriated phrases to express them. New notions require new words to denote them, as new combinations of thoughts, of which the variety is endless, require new phrases and sentences. In this way, languages gradually improve, at least in point of richness, copiousness, and precision.

BUT it is only the most frequent of all combinations of thought with that which is the general meaning of a verb, such as affirmation, interrogation, command, wish, &c. that are expressed by such inflections or variations of the primary verb, as may be called grammatical moods. These are the combinations of thought, in the expressing of which, circumlocution, or tediousness of any kind, would be the most disagreeable and inconvenient; and for which, therefore, a quick and simple mode of communication is most requisite. Many other combinations of thoughts may be expressed by the combination of different verbs with sufficient quickness, and without inconvenience or disagreeableness of any kind. The number of grammatical moods cannot be infinite. It is plainly limited, partly by the difficulty of contriving a great number of distinct inflections;

flections, partly too from the obvious difficulty of remembering and employing accurately even such a number as might undoubtedly be contrived, but much more from there being no urgent occasion for such a variety of them ; many of the combinations of thoughts to be expressed by verbs being so near akin, that they would naturally be classed together, and might be denoted by one grammatical mood, without danger of any ambiguity or obscurity ; as for instance, the various moods of thought which are occasionally expressed by the grammatical imperative, or by the future tense of the indicative ; all the distinctions of which moods of thought, both in kind and in degree, may be fully understood by those to whom the discourse is addressed, from a variety of well known or obvious circumstances. Hence I think it appears very natural, that though the possible number of grammatical moods be very great, (though by no means infinite) the number of actually subsisting moods in different languages should be very small ; and that some, even of these few, should occasionally be employed with little distinction ; the ingenuity and labour of mankind in contriving, and their precision and steadiness in employing such moods, being chiefly regulated by the experience of what they daily had occasion for.

V. THE fifth of those conclusions respecting the importance of grammatical moods towards the perfection and beauty of language, by the quickness, animation, and force, which they give to the expression of our most familiar and most interesting modifications of thought, can require no other proof but mere illustration by proper examples, any number of which may easily and readily be found. And from these it will plainly appear, that the moods of verbs are in a manner essential to eloquence of almost every kind. “ *L'éloquence*” (as M. D'ALEMBERT very justly observes, and proposes to define it) “ *est le talent de faire passer avec rapidité, et d'imprimer avec force,*

“ dans l’ame des autres, le sentiment profond dont on est péné-
 “ tré. Cette définition convient à l’éloquence même du silence,
 “ langage energique et quelquefois sublime des grandes pas-
 “ sions ; à l’éloquence du geste, qu’on peut appeller l’éloquence
 “ du peuple, par le pouvoir qu’elle a pour subjuguier la multi-
 “ tude, toujours plus frappée de ce qu’elle voit que de ce qu’elle
 “ entend ; enfin à cette éloquence adroite et tranquille, qui se
 “ borne à convaincre sans emouvoir, et qui ne cherche point à
 “ arracher le consentement, mais à l’obtenir. Cette dernière
 “ espèce d’éloquence n’est peutêtre pas la moins puissante ; on
 “ est moins en garde contre l’insinuation que contre la force.”
 D’ALEMBERT *Discours à l’Academie Française, et Reflexions sur*
l’Eloquence Oratoire. Melanges, Vol. II. p. 304, 305. 319.

OF all the moods of thought which are commonly expressed
 by grammatical moods, the indicative (comprehending the
 simple *subjunctive*) though one of the most important, and
 most frequently employed, is plainly one of the least animated
 or interesting, from the nature of the thought expressed by it,
 which is merely proposition, that is, affirmation and negation.
 Though animation and force be little needed, yet brevity and
 quickness are of much consequence in the expressing of this
 combination of thoughts. Had we not an indicative mood to
 express it briefly, and in one word, our conversation and writ-
 ing would be intolerably slow and tedious, and consequently
 feeble and disagreeable. We should be obliged to employ at
 least two verbs instead of one, and after all should have but a
 very inaccurate and clumsy expression of a thought, which we
 should wish to communicate as precisely and distinctly as possi-
 ble. *Fuit Ilium* could not be resolved into *Dico Ilium fuisse* ;
 for *dico* is itself an indicative, resolvable in the same way with
fuit ; *aio, inquam, assero, assevero, &c. me dicere*. Without the use
 of grammatical moods, we could get no nearer to a resolution
 of *fuit Ilium* than *ego dicere fuisse Ilium*. Or dropping the in-
 flexions which serve to distinguish the infinitives from the
 moods,

moods, properly so called, and taking only the roots or bases of the verbs respectively, *Ego dic—fu—Ilium*. Any person may easily try the effect of such a resolution of any plain elegant composition, either in prose or verse, wherein the indicative and simply subjunctive moods are chiefly or solely employed; as for instance, the following beautiful lines of OVID, containing an account of PYTHAGORAS.

*Vir FUIT hic ortu Samius : sed FUGERAT una
Et Samon et dominos; odioque tyrannidis exul
Sponte ERAT : isque licet cœli regione remotus
Mente deos ADIIT : et quæ Natura NEGABAT
Visibus humanis, oculis ea pectoris HAUSIT.
Cumque animo, et vigili PERSPEXERAT omnia cura,
In medium discenda DABAT : cætumque silentum,
Dictaque mirantum, magni primordia mundi,
Et rerum causas, et quid Natura, DOCEBAT :
Quid Deus; unde nives; quæ fulminis ESSET origo :
Juppiter, an venti, discussa nube TONARENT :
Quid QUATERET terras; qua sidera lege MEARENT ;
Et quodcunque LATET. Primusque animalia mensis
ARCUIT imponi : primus quoque talibus ora
Docta quidem SOLVIT, sed non et credita, verbis.*

IN these fifteen lines, there are sixteen verbs, either in the indicative or in the simply subjunctive mood. Without the use of such a mood, the thoughts expressed in the lines, simple and easy of apprehension as they may appear, could hardly have been expressed intelligibly; or if this, with much labour and ingenuity, could be accomplished, still the beauty, the charm, of the composition would be completely lost. The poet, the orator, the philosopher, the historian, and indeed every person who has the gift of speech, or who makes use of language in any way, has almost constant occasion to employ that mood,
and

and must severely feel the want of it, whatever resolution or circumlocution he might contrive instead of it. It is evident, that, in many cases in real life, a slow and tedious expression of the thought denoted by the indicative mood, supposing that it could be made sufficiently intelligible, would not only be disagreeable, but might scarce serve the purpose required; it might come too late. In certain circumstances, a person's life and fortune may depend on his quickness in expressing what he means to communicate. Even where nothing of that kind is at stake, the difference between a quick and a slow tedious expression of thought, is very striking and important. Language is at best, and after all its improvements, not only less perfect and accurate, but incomparably slower, than thought; the quickness of which is proverbial, and with great reason. I believe it is even in many cases much quicker than we are commonly aware of. We all know, that we can, in a very few seconds, recollect a vast number of things in succession; such as the various circumstances of a story, in which perhaps many different persons were concerned, and many different events occurred, or the various scenes through which we passed in the course of a long journey. But to tell such a story intelligibly, or to describe particularly such scenes, even with the help of the most perfect language, might be the work of hours. In a certain state of imperfect sleep, in which dreams most commonly occur, or at least are most distinct and best remembered, the train of thought appears to be incomparably quicker than we can ever make it, while awake, by any voluntary exertion. There is reason to think, that sometimes a sudden noise, which, to a careless observer, might seem to waken a person instantaneously and perfectly, may yet give occasion to a *long* dream, in an almost imperceptible interval of time. I call the dream *long*, though it may pass in a single second or less, when it consists of a great or numerous series of imaginary events, the narration of which would be long in
point

point of time ; like the adventure of the Sultan in the Arabian Nights Entertainments, who, on dipping his head into water, had a long and vexatious series of adventures, for seven years, as he thought, in the short space of time in which his head was in the water. Even when we are awake, a voluntary train of thought, especially when much connected with emotion or passion, is sometimes so quick that we are unable to express it in words, or at least to do it any justice in point of quickness. Before we can express even the hundredth part of it, the rest of it is gone, and cannot be recalled but slowly, and with much labour. We can often observe, both in common conversation, and in public speaking, that a person hath gone on much farther in thought than he has expressed in words. Many people cannot tell to any purpose either a ludicrous or a pathetic story for laughing or weeping. The whole train of thought rushes on their minds so quickly as to overpower them with its full effect, before they have expressed enough to let their hearers know any thing of it, nay sometimes before they begin to speak.

*Format enim natura prius nos intus ad omnem
Fortunarum habitum : juvat aut impellit ad iram;
Aut ad humum mœrore gravi deducit et angit :
Mox effert animi motus interprete lingua.*

SOME of the most interesting modifications of thought, I mean emotions and passions, express themselves by natural language, that is by the countenance, voice and gesture, almost as quickly as they are conceived ; and when they are expressed in this way, they are not only well understood by others, but are often in some measure communicated to them. For such is the nature of man, that, independently of all religious precepts, and of all moral considerations, we are strongly, and often irresistibly disposed to rejoice with those that do rejoice,

joice, and weep with those that weep. This we must all have seen, and to a certain degree felt, even in common conversation. We can often observe, that one very cheerful, or one very melancholy person quickly communicates his state of mind to a whole company. We feel the same to a still greater degree in scenes of real distress, or of violent emotions of any kind, and often to a very high degree from exquisite theatrical representation. The same principle extends to the spreading of the military ardour or of a panic among soldiers, of civil fury among a mob, and of religious fanaticism, sometimes even among people who did not apprehend any such danger to themselves.

NEXT to this instantaneous and most effectual expression and communication of thought by natural language, is the quick transmission of it by very brief expressions in artificial language. The beauty and force (that is, the quick, and powerful, and pleasing, effect) of such quick and brief expressions has been generally acknowledged, and felt, and admired. The chief, and sometimes perhaps the only merit of certain apophthegms, or good sayings, consists in the brevity, and consequently force of the expression *. Among the Spartans, this style of speaking and writing was so much admired as to become a matter of study, and consequently sometimes of affectation. It is certain, that many thoughts, which appear striking and admirable, when expressed in one or two words, are feeble and frivolous, when expressed at full length, especially when put into pompous language. On the same principle too, we may understand how it comes to pass, that brevity, and the employment of few and simple words, are essential to the sublime in literary composition ; which is a well known and important fact.

WE are so apt to be disgusted with a very full and precise expression of thought, especially on subjects which are familiar

to

* Videfis PLUTARCH's Apophthegms.

to us, or at least are supposed to be so, that many people who are accustomed to the elegant, and often concise and animated, compositions of historians, orators, and poets, cannot be reconciled to that accurate enunciation of propositions and of arguments in proof of them, which is often indispensibly necessary for strict reasoning; or if they can bring themselves to listen to the propositions and demonstrations of geometry, when expressed in this way, they will not so readily admit that there is the same occasion for such fulness and accuracy of expression on any other subject, not even in metaphysics; hence the vague, inconclusive, and often absurd reasonings, which have produced both disgust and distrust of such speculations.

GRAMMATICAL language, in general, and especially the modern languages, afford such flow expressions of thought, that often before we have heard or read the half of a sentence, we apprehend the meaning of the whole of it, and, of course, the latter part of it is not merely superfluous and tedious, but in many cases quite disgusting.

IF we could express our thoughts by grammatical language as quickly and concisely as we can by natural language, and without losing any thing of that distinctness and precision which artificial language gives to the expression of them, it would unquestionably be a great improvement in language, in point of agreeableness, animation, and force. I doubt whether it would be equally favourable in science. I am disposed to think that the slowness, or even tediousness, of the expression of our thoughts on certain subjects of profound reasoning, has its use, by giving us time and opportunity, and almost forcing us, to attend to every particular thing, and its relations to other things, about which we reason. But even this has its limits; and mathematical demonstration itself, as we find it in the writings of the ancient geometers, is but an abridged chain of syllogisms. And it is still further abridged in many cases, by those who are perfect masters of it, by omitting many of

the more minute and easy steps which those who are well accustomed to such reasonings quickly and easily supply for themselves, and find pleasure in this quickness and brevity; while, on the contrary, they are tired and disgusted with that slow and tedious exposition of every step in the reasoning, which to them is needless, but perhaps would be necessary for the instruction of those of inferior talents and knowledge.

A GRAMMATICAL language, as quick as thought, and as concise as natural language, is manifestly unattainable. But every approximation to it is valuable. All the moods of verbs, even the indicative and the simple subjunctive, are such approximations.

If these observations be true, with respect to the indicative and simply subjunctive mood, and the plain and tranquil expression of mere proposition, how much more important and striking must the corresponding differences be, between the concise and quick expressions of such interesting and animated combinations of thoughts, as interrogation, command, wish, &c. by the grammatical moods of verbs, and the slow, languid enunciations of the same or similar thoughts, by circumlocution and the use of additional verbs?

THERE is a just and beautiful observation of LONGINUS, relating to this subject, which will fairly admit of much more extensive application than he has made of it, and is in truth more important than he seems to have been aware of. He takes notice of interrogation as a figure of rhetoric, by which an orator endeavours to render the expression of his thoughts more animated and forcible. Τι δ' ἐκεῖνα φάμεν τὰς πεισσεις τε καὶ ἐρωτήσεις; ἀρα οὐ αὐταῖς τὰς τῶν σχημάτων εἰδοποιῖαις παραπολυ ἐμπρακτοτέρα καὶ σοβαρώτερα συντείνει τὰ λεγόμενα; LONGINUS *de Sublim.* Sect. xviii. This opinion he illustrates, in some measure, by the manner in which he expresses it, namely, by the use of the very figure of interrogation of which he is treating; and still better by a very apt quotation from the first Philippic of

of DEMOSTHENES. Η βελεσθε, ειπε μοι, περιμοντες αλληλων πυνθανεσθαι κατα την αγοραν, λεγεται τι καινον; γενοιτο γαρ αν τι καινοτερον, η Μακεδων ανηρ Αθηναιους καταπολεμων, και τα των Έλληνων διοικων; τεθνηκε Φιλιππος; ου μα' Δι' αλλ' ασθενει' τι δ' υμιν διαφερει; ΞC.

THE justness of LONGINUS's remark on this passage, and indeed his general observation with respect to the animation and force of interrogation, employed as a figure of rhetoric, can, I think, admit of no dispute. But even the truth of it, and our ready acquiescence in it, implies that he was, and that we too are, sensible of something more animated and forcible in an interrogation, even literally employed, as in common life, than in a circuitous expression of the same thought; else it never could have been employed, nor thought of, as an animated figure of speech.

EVEN the simple interrogation, *Who is that?* is evidently more animated and forcible, as well as more concise, than *I desire you to tell me who that is*, or *I desire to be informed who that is*. The same is equally obvious with respect to *go, come, do this, te spectem, te teneam, υμιν μεν θεοι δοιεν*, if we compare them with *I order you to go, I command you to come, I desire you to do this, cupio te spectare, opto te tenere, λισσομαι τις θεος υμιν διδοναι*, or, *λεγ— λισσ— θεος υμιν δο—*; which is employing merely the roots, without any inflection whatever of the three verbs, the meaning of all of which, to wit, affirmation, wish, and giving, is briefly, but fully and clearly, and consequently forcibly expressed by the Greek optative *δοιεν*.

THE more urgent the occasion is, and the more interested the passions become, the more important is the brevity and force of these moods to the expression of our thoughts. This, which is obvious even in common life, is still more striking in those animated and interesting representations of real life, which we have in dramatic poetry; to a great part of which it may fairly be said that these moods are essential.

IN the great discovery scene in *Oedipus Tyrannus*, there are not fewer than 150 interrogative and imperative sentences ; any one of which would be murdered, and the effect of the scene spoiled, by using circumlocution by means of a verb of asking or of commanding.

IN the passionate scenes of *Lear* and of *Othello*, several hundreds of similar instances may easily be found.

IN the discovery scene in *Douglas*, some of the finest strokes of passion, of anxiety, of wonder, of horror, of eager curiosity, are conveyed by means of the moods of verbs, and would be lost in any circumlocution.

Was he alive ?

— *Inhuman that thou art*

How couldst thou kill what winds and tempests spared ?

EVEN ROWE, amidst all his golden verse, was not unmindful of the force and animation which the moods of verbs give to the expression of thought.

— *Does he ? Does Hastings ?*

Reward him for the noble deed, just Heaven.

For this one action, *guard* him, and *distinguish* him,
With signal mercies, and with great deliverance ;
Save him from wrong, adversity, and shame ;
Let never fading honours *flourish* round him ;
And *consecrate* his name even to time's end ;
Let him know nothing else but good on earth,
And everlasting blessedness hereafter.

The poor, forsaken, royal little ones !
Shall they be left a prey to savage power ?
Can they lift up their harmless hands in vain,
Or *cry to Heaven* for help, and not be heard ?
Impossible !

Go on, pursue, assert the sacred cause, stand forth and save.—
Jane Shore, act 4. sc. 1.

*Alas ! I never wrong'd you—
 Oh ! then be good to me, have pity on me ;
 Thou never knew'st the bitterness of want,
 And may'st thou never know it. Oh ! bestow
 Some poor remain——*

Allow me but

The smallest pittance. *Act 5.*

THE genius of SOPHOCLES and of SHAKESPEARE, and the talents of GARRICK and SIDDONS united, could not make such sentiments as those of *Lear*, and *Othello*, and *Oedipus*, and *Lady Randolph*, and *Jane Shore*, interesting, or even tolerable, to any reader or spectator of taste and judgment, if they were expressed in minute detail, by such circumlocutions as the grammatical moods of verbs may be resolved into.

THE finest instance that can be given, or indeed supposed, of the truth of this principle, we have in HOMER, in the admirable speech of *Priam* to *Achilles*, when he goes to beg the body of his son *Hector*. This speech has been universally admired, as perhaps the most eloquent that ever was composed. Though it be exquisite in every part, the exordium, and indeed the very first sentence of it, is by far the most striking and eloquent part of it. This too HOMER seems to have felt and understood perfectly ; for he makes *Priam* repeat the same thought, and almost in the same words, at the end of his speech, by way of peroration, and with a very happy effect. When *Priam* enters the tent of *Achilles*, and throws himself at his feet, his address to him is most singularly striking.

Μνησαι πατρος σείο θεοις επιεικελ' Αχιλλευ,
 Τηλικα ὥσπερ ἐγών, ὀλοῶ ἐπὶ γηραὸς οὐδῶ.

Think

Think of thy father, O god-like Achilles, old like me, and on the brink of the grave. Possibly there is a force and propriety in the use of the aoristic imperative *μνησαι*, instead of the present imperative, which would be more intelligible to HOMER's countrymen than it can be to us. Perhaps to them the difference between those two forms of the imperative mood might be as great as it is to us between *think of* and *be thinking of*, the imperative of the aorist being a more vehement, sudden and urgent request or command than the imperative present *μναου*, but yet not disrespectful, like the imperative perfect *μεμνησο*, which, I believe, might be addressed to a slave, but could not, with propriety, be employed by a suppliant to an equal or to a superior.

SOME nicety and delicacy of this kind seems to be expressed in the conclusion of *Priam's* speech, by the use of the imperative present of one verb, and the imperative of the aorist of another, in the same line.

Ἀλλ' αἰδεῖο θεας Ἀχιλεῦ, αὐτὸν τ' ἐλεησον,
Μνησαμένος σε πατρός·

Αἰδεῖο, *αἰδου*, *αἰδεου*, is the imperative present of *αἰδεομαι*; *ἐλεησον* is the imperative of the aorist of *ἐλεω*. The former seems a more tranquil and cool request, or rather advice or suggestion, and refers to a continued, or frequently repeated, action, state, or habit, to wit reverence to the Gods. The latter is a more urgent supplication for immediate pity and favour; as if he had said, *Be ever mindful of your duty to the Gods, and instantly (or at this time, moment, &c.) have pity on me.*

WHATEVER may be thought of these speculations and refinements, it can never be doubted, that if, instead of the imperative mood, we were to use a circumlocution, to express the warm and vehement sentiments of *Priam*, it would be insupportable; *λίσσομαι σε μνησασθαι σε πατρός—αἰδεῖσθαι τας θεας—αὐτὸν ἐλεησαι.* Such a slow and languid expression would have suited

suited ill with those sentiments and actions which HOMER attributes to *Priam*. Indeed his actions, without his speaking at all, would have been more pathetic and persuasive than they would have been with such imperfect and improper expressions of his thoughts; but by means of the moods of verbs, it is possible to unite, to a certain degree, the advantages both of natural and of artificial language.

WE have many instances in poetry, as well as in oratory, of the *figurative* use of such moods as I have just now been considering, and the effect of it, in enlivening and enforcing the expression of the poet's sentiments, is very striking.

*Can storied urn, or animated bust,
Back to its mansion call the fleeting breath?
Can 'honour's voice' provoke the silent dust?
Or flattery sooth the dull cold ear of death?*

*What female heart can gold despise?
What cat's averse to fish?* GRAY.

BUT while I thus point out how great a share the conciseness of the expression of many thoughts, by means of grammatical moods, has in giving animation and force to language, I beg it may not be thought that I impute the animation and force of such expressions *entirely* to that conciseness. Many of the thoughts to be expressed are in themselves highly animated and interesting; and, on this very account, conciseness in the expressing of them is peculiarly agreeable, and even necessary.

VI. THE sixth and last conclusion respecting the import of the moods of verbs, is very intimately connected with the preceding. It relates not merely to the brevity and quickness of the expression of thought, but to the intimate combination, and simultaneous exhibition, of the signs of thoughts, which
thoughts

thoughts are themselves co-existent, and most intimately combined. To this great property of thought, which has never yet been considered with that attention which it deserves, inflections of words, and especially the moods of verbs, do some kind of justice; while circumlocation of every sort, even though it expresses all the different thoughts, does manifest violence.

To explain this fully, would require a much longer and more elaborate disquisition concerning the nature of human thought than would be proper here. It may, however, be, in some measure, understood, by observing, that grammatical language, though the noblest of all human inventions, or, as some conceive, an art beyond the reach of our unassisted faculties, and imparted to us by a kind of immediate inspiration from Heaven, is, by no means, absolutely perfect, nor even capable of ever becoming so. It answers admirably well for denoting many of our thoughts, either singly, or in various relations, particularly in succession, and is even subservient to the precision and steadiness of thought, by the subdivision or decomposition of the mass of thought which it requires, and obliges us to make, not merely for the inventing, but for the learning, and the occasional using, of language. It is indeed in many ways the chief instrument in the improvement of human reason. But in one very important respect, it is almost incongruous with the nature of that thought which it is employed to represent.

THE artificial signs, whether audible or visible, that we use in grammatical language to denote our thoughts, are necessarily arranged, either in the order of time, or in that of place; and when we see the visible signs arranged in the order of place, (as in reading) we attend to them, and occasionally give them audible utterance in the order of time.

BUT our thoughts themselves are not arranged in either of those ways. It is self-evident, that thoughts cannot be arranged in the order of place; at least this will be self-evident to every person

person who can shake off the long established philosophical hypothesis of *ideas*, or images of things in the mind, as subservient to thought ; or even who will take the trouble to distinguish between such supposed images, which, like those of a magic lanthorn, may be conceived to be arranged in place, and the thoughts corresponding to them. And I believe it is equally certain, though not equally evident, that *many* of our thoughts are not even arranged in the order of time, but are related to one another in a very different manner, which is well understood, as being perfectly familiar to us, but which cannot be represented merely by the arrangement of words.

THAT *many* of our thoughts are arranged in the order of time, or, in other words, that there is a train or succession of thought, is, I think, too evident and generally acknowledged to require either proof or illustration ; and this relation among our thoughts may be fairly and completely represented by the succession of audible words, and of course with sufficient propriety by the arrangement of visible words.

BUT this is perhaps the least important of all the various relations of thought. Besides the train or succession of thoughts in time, there is often at once a great combination or mass of thoughts variously related to one another. Such a mass of thought we sometimes wish to impart entire and all at once ; sometimes we wish to analyse it, to break it down, as it were, and either to attend to it ourselves, or to impart it to others, that they may attend to it, piece-meal.

FOR the latter purpose, the arrangement of words in grammatical language is admirably well adapted ; for the former, it is in a great measure unfuitable. It gives disjointed, and in succession, those thoughts which we have united and simultaneous, and wish to communicate in the same way.

HENCE the importance of the great principle of inflection in grammatical language, and its superiority to mere arrangement of words : Hence too the superiority of those languages which, having many and distinct inflections, admit of great variety

of arrangement. This is scarce required for mere reasoning, but is of great value in poetry and eloquence, not only in point of sound, but sense, both with respect to the force of it, and the justness of the expression of the various complicated and simultaneous relations of the things conceived.

Now, to inflection the moods of verbs plainly belong; and by them we express the simultaneous combinations of the thoughts or *energies* of affirmation, interrogation, wish, command, and many others, with the thought or *accident* expressed by any verb; and when we express these combinations by resolution or circumlocution, by means of two or more verbs, we, in some measure, separate in words what was most intimately blended in thought, and represent as successive what we conceived, and wished to impart, as simultaneous.

THIS doctrine will not be admitted by those philosophers who have assumed or admitted as a principle, that a person can have but one thought (or *idea*) at once. But this principle I disregard, as I know of no proof of it, and as it seems to me inconsistent with many obvious phenomena, and even repugnant to direct consciousness. I suspect that it has been adopted in consequence of very careless observation, both of thought and of language; and I think it of some consequence to be aware of the error of such an opinion; for though it may appear, at first view, of little importance, whether we admit the simultaneous presence, or only the immeasurably quick succession of different thoughts, yet the difference of these two principles may be found very great, on tracing their several consequences. With respect to the moods and other inflections of verbs, I cannot think it should admit of doubt, that they are employed and understood to denote combinations of simultaneous thoughts, no one of which can reasonably be said to occur to the person speaking, or to be apprehended by the person hearing, before the rest. *Specto, spectemus, specta, spectaverunt, spectavitne?* All nouns, even proper names, denote a congeries of circumstances,

stances, or a *mass* (not a *train*) of thoughts, which are conceived at once, and cannot be separated and considered in succession, but by a very laborious effort. Many single words, for example prepositions, and most sentences, denote some kind of relation; but we cannot, I think, conceive a relation, without thinking at once of the things (two or more) that are related, as well as of the relation (both in its generic and in its specific nature) that subsists between them.

MATHEMATICAL propositions are expressions of co-existent thoughts, the objects of which (at least in pure geometry) bear no relation at all to time; and these, to be conceived rightly or at all, must be conceived at once. Any ordinary person can do this with respect to an axiom, or even a very simple proposition; and good mathematicians can do it with respect to very long and complex theorems, some of which ordinary people find almost insuperable difficulty in apprehending. Part of this difficulty (as I feel very plainly in myself) arises from the number of things and relations that are to be thought of at once, and accordingly is not immediately removed, nor is it obviated, by even the most distinct and just conception of every one of those things and relations taken singly. Corresponding to this difficulty in a learner, and just the opposite of it, is that of a teacher of almost any science, and often of a speaker, either in a public assembly or in common conversation, who may have a clear and just conception of a great mass of thought, which he wishes to communicate to others, but can scarce contrive to do so, nor knows he well where or how to begin; and perhaps when he has begun right, or at least distinctly, soon falls into such confusion and perplexity, as makes him almost or quite unintelligible to his hearers, even when he understands himself perfectly, and may know that another, more fortunate in the talent of communicating thought, has *helped him out*, or expressed distinctly and properly that very meaning which he was endeavouring in vain to convey to his hearers.

though as well acquainted as the other with the proper words to denote every portion or fragment of the great congeries of thought.

THERE is reason to think, that there are much greater differences among mankind, with respect to that capacity or comprehensiveness of mind, by which they take in, or attend to, at once, a variety of objects and relations, than there are with respect to the conception or simple apprehension of any one of them by itself. And that comprehensiveness of mind, which is in truth a most valuable talent, both with a view to speculation and action, may be improved by various means, especially by frequent exercise, and may be assisted by many expedients.

A PERSON who, when he first begins the study of mathematics, can apprehend only the axioms and the simplest propositions, after a few months or years employed in that study, will easily apprehend, not only the proposition, but the demonstration of complex theorems, which are masses of co-existent thoughts, that could not be expressed by the succession of words in less than several minutes, nor by the arrangement of words in less than several pages.

THE succession, and even the best arrangement of words are found so unsuitable for the expression of such combinations of thoughts as occur in many mathematical propositions, that other expedients are very generally and properly employed to assist us in making or in communicating these complex operations of thought.

DIAGRAMS and algebraical formulæ answer these purposes admirably well. Neither of them, strictly speaking, is essential to mathematical demonstration; but both of them are highly useful in it, and many good mathematicians would be at a stand if they were deprived of them. A good *construction* or diagram will suggest instantaneously the whole congeries of thought which constitutes both the proposition and the demonstration of a theorem. A good *expression* in algebra answers nearly the same purpose; and suggests, almost instantaneously, such a mass of thought, without confusion, as never could have

have been conveyed by common words in succession and arrangement, by reason of the great length of time required to utter or to read them; in the course of which time, many of the particular thoughts composing the mass would be gone, before others were suggested or produced, with which they ought to be combined, to enable us to perceive their various relations.

THE analogy between the diagrams and formulæ of mathematicians, and the moods of verbs, and other inflections of words in common discourse, which I endeavour here to point out, is not so distant as may at first sight appear. They agree in this, that all of them express, infinitely better than any succession or arrangement of words can do, combinations of thoughts, which are almost or perfectly co-existent, and which, by means of them, are apprehended more justly, more quickly, and more forcibly, than otherwise they could be.

AND let it be remembered, that the objects and relations which occupy the minds of geometers, though more abstruse, and requiring a greater voluntary effort of thought, than those which engage the attention of ordinary men, are not more numerous or complicated, but in general much less so; and that they admit more easily, and with less injury, of being broken down, and given successively, at least with a view to demonstration, in which no great quickness is required. Hence, in a great measure, the clearness and force of mathematical reasoning.

THE masses of co-existent thoughts which we often meet with in common discourse, or in elegant composition *in full periods*, are of incredible extent, as appears on our endeavouring to analyse them, and express in detail the various parts of the complicated meaning which we apprehend.

THE first seven lines of the Iliad, containing about forty words, and the first sixteen lines of Paradise Lost, containing about one hundred and twenty words, denote respectively a
mass

mass of co-existent thoughts, not a train of successive thoughts. The thoughts expressed in them are much more numerous than the words, as plainly appears on endeavouring to explain or define all the words, even in their most general radical meaning, which is rendered still more complicated, that is, expressive of more thoughts, by the inflections of many of them, especially in the Greek lines. We can attend to different parts of that mass of thought, at our pleasure, regardless of the rest, or we may take in, more or less clearly, the whole at once, as the authors certainly did in composing the lines; or we may attend accurately to the meaning of every word singly. And if this be done very slowly, and with long intervals between every word, the meaning of the whole lines, as a sentence or period, will be lost; nor can we, in such a way of reading or pronouncing HOMER's or MILTON's lines, make sense of them, but by a voluntary and painful effort of memory, to retain, or recal, the former words and thoughts, till the latter are suggested and duly combined with them. The words of the finest period that ever was composed, when read or uttered one by one at the interval of a few minutes, or even seconds, will no more have the effect of the period properly read or uttered, in point of thought, than an equally slow sounding of the various notes in a piece of music will have, in point of melody or harmony, the effect of the music properly performed; or than the successive and slow inspection of the different rainbow colours will have, in giving the perception of white, which they would give, if contemplated at once properly blended, or even if contemplated in very quick succession.

AFTER all, perhaps the best illustration of this important principle is that of the Indian orator, mentioned in the Origin and Progress of Language, Vol. IV. p. 22. "I have heard a story" (says the learned author of that work) "of an Indian orator, who, at a congress or *talk*, as they call it, with the then British governor of Florida, Commodore JOHNSTON, being

“ being frequently interrupted by the interpreter, who stopped him in order to explain to the governor what he said, at last lost patience ; and, says he, *I can bear this no longer. My discourse, cut thus into pieces, can have no more effect than the water could have on that great beast of yours,* (pointing to a saw-mill at some distance) *if it were to fall upon it drop by drop.* Now, this orator must have had as perfect an idea of the *flumen orationis*, and the effects it produces, as a CICERO or DEMOSTHENES.” The same author has many just and striking remarks on the force, the beauty, and the *comprehensiveness* of composition in periods, (page 239, 240.) and of inflection of words, (page 14. *et passim.*) And all of these observations may fairly be applied to the moods of verbs. What proper periods are to very great and complicated masses of thought, inflections, including moods, are to the more familiar and finaller combinations of thoughts, which we almost every moment experience, and wish to express united as we conceive them.

* * * *

As I think it of essential importance, in all scientific investigations, never to blend *hypotheses*, or matters of opinion, with evident matters of fact, and strict inferences by induction from them ; it is proper to point out, that no hypothesis whatever, with respect to the original state, or the formation, or the improvement, of language, is assumed in this Essay.

It has generally been supposed, or taken for granted, in all reasonings about the theory of language, that, in a very early period of its progress, perhaps from its very origin, it was rude and simple, almost destitute of inflections, (such as the moods of verbs) and in a great measure or wholly monosyllabic ; and that all manner of inflections and modifications, by composition, by augment, or otherwise, were gradually given, in a slow progress, to those monosyllabic roots, by deliberate human contrivance.

THAT

THAT this has taken place, to a certain degree, in many languages, and to a very great degree in some, cannot be disputed. In Greek, for example, we can, with the greatest ease, refer some thousands of *words* (counting every variation by inflection, by augment, or by composition, as a different *word*) to one simple root, such as λεγ.

IN some languages, it seems probable that the usual progress and improvement has not taken place, they remaining very long in a monosyllabic state. This has certainly been the case with the Chinese language, for some thousands of years; probably, in part at least, the consequence of that great, civilized and ingenious people persisting in the use of hieroglyphic characters, immediately significant of thought, without any direct relation to audible words, like the Indian figures that we use in common arithmetic, and never adopting the noble invention of alphabetic characters, directly expressive only of sounds, the combinations of which sounds are immediately significant of thought.

BUT some ingenious men have been of opinion, confirmed, as it is said, by actual observations of the languages of some very rude nations, especially in America, that some languages at least, perhaps all, were, in a very early period, polysyllabic to a most inconvenient degree; the words of them being very long, and significant of very complicated meanings, like phrases or whole sentences of ours. It has been thought, that these unwieldy long words may have been gradually broken down into shorter, and even into monosyllables; which, in a further progress, might be varied again by inflection and otherwise.

IT is certainly conceivable, and not very improbable, that mankind, in their first rude attempts towards forming a language, might not perceive the vast advantage to be gained by subdividing, and breaking down as it were, the great mass of thought which they conceived, and wished to communicate. They might attempt to give utterance by one word to all the
mass

mass of thought which they had to express. Thus, *Give me a bow*, might be expressed by one word; *Give me food*, by another; *I saw a friend, an enemy, a beast, a man, a woman*, by as many different words; no distinction being made between noun and verb, agent or subject, mood or accident. But the inconvenience of such a language would soon be felt and gradually remedied; and the first and most natural step would be to employ the same word for *give*, whatever was to be given, one word for *see*, whatever was seen, and to employ different *nouns* to denote the substances given or seen. But this implies the previous exercise of a faculty of a higher order than that of dividing the voice, or forming articulate sounds. The same power that has made us *Megacles*, hath also taught us to divide our thoughts. Indeed, without this nobler faculty, which seems to be denied to all the inferior animals, and is scarce perceptible in man during the first months of his life, the other would be of little value. Several animals have learnt to divide the voice, or to articulate, better than many unfortunate individuals of our own species, who were deficient in the proper organs of voice and speech; but none of them have ever learned to make use of speech as we do. They probably always, and children for some time, make no attempt to separate or analyse their thoughts. Till that be done, which our superior faculties soon enable us to do, the very fundamental notions of the parts of speech cannot be conceived, grammatical language cannot be contrived, nor even if it were presented to us ready made, in all the perfection of the Greek of DEMOSTHENES, could it be either learned or employed.

ON the former supposition, (page 247.) the moods of verbs must be conceived to be *added* to them in the course of the formation or improvement of language.

ON the latter supposition, they must be conceived to be *retained* in language, and to be a remnant of a very rude polysyllabic

labic state of it, which, though inconvenient on the whole, had some advantages.

SOME *expressions* occasionally employed in this Dissertation, may seem to favour or to imply the former supposition. But that is not meant. Neither hypothesis is assumed in the reasoning. Those expressions have always been employed with caution and distrust, and merely in compliance with custom, a deviation from which might have seemed to imply the opposite hypothesis, and would have required a new, and, in some measure, an embarrassed and uncouth mode of expression.

BOTH hypotheses are equally indifferent to this Theory of the Moods of Verbs, which is independent of all hypotheses, and does not extend to the *history* of the first appearance of *moods*, nor to the question, whether they be added to language in its progress, or retained in it when perhaps many other inflections were laid aside. They may be partly both, or their history may be different in different languages. All that is attempted in this Theory of the Moods of Verbs, is only to investigate the nature and import of them more accurately than had been done before, and to shew what valuable, and almost indispensable purposes they actually serve in the communication of thought.

VII. *An ESSAY on the CHARACTER of HAMLET, in SHAKESPEARE'S Tragedy of HAMLET. By the Reverend Mr THOMAS ROBERTSON, F. R. S. EDIN. and Minister of Dalmeny.*

[Read by Mr DALZEL, Secretary, July 21. 1788.]

THE *Character* of HAMLET, has been variously judged of by critics, and what might be expected, it has been still more variously represented by performers upon the stage. SHAKESPEARE himself seems to have apprehended that this would happen; and that injustice would be done to a hero, who probably, in his estimation, ranked higher than any other that he has brought into the drama.

WHEN HAMLET was dying, he appears, upon this account, to have made him speak as follows to HORATIO.

—— HORATIO, I am dead;
Thou liv'st; report *me* and *my cause* aright
To the unsatisfied.
Oh good HORATIO, what a *wounded* name,
Things standing thus unknown, shall live behind me.
If thou didst ever hold me in thy heart,
Absent thee from felicity a while,
To tell my tale.

HAMLET was here in a situation in which men in general speak truth; and he was besides speaking to a confidential friend,

friend, who could not be imposed upon ; a friend who, from the strongest possible attachment to him, had been about to put an end to his own life, but was restrained from his purpose, in order to explain to a " harsh world," the story of HAMLET, after he was no more.

AND when HAMLET dies, HORATIO pronounces this eulogium :

Now cracks a noble heart ! good night, sweet prince ;
And flights of angels sing thee to thy rest.

SHAKESPEARE, in these passages, not only refers to the particular part which HAMLET had acted, with respect to the usurper, (which he calls HAMLET's *cause*) and which, upon being explained, would vindicate what he had done. He plainly intimates by the mouth of HORATIO, his own idea of HAMLET's character, in all other respects ; as not only heroic and splendid, but perfectly consistent, amiable and just ; and further, from the danger that HAMLET himself, as well as his cause, might be exposed to the censure of the unsatisfied, he seems strongly to insinuate, that the character could not be comprehended, unless an enlarged view were taken of it, and of the different situations in which it had been placed.

HAMLET's conduct in having put the king to death, was, in a great measure, already justified, in the very hearing of the lords, and other attendants upon the court, who were witnesses to it. The queen, who had just expired in their sight, had said she was " poisoned." HAMLET had called out " villany !" Even LAERTES, the treacherous opponent of HAMLET, had declared, " the king, the king's to blame—It is a poison tempered by himself." And HAMLET, upon stabbing the king, had expressly charged him with " murder." All this passed in the presence of the court, who would hence be led to view the king as guilty of having poisoned the queen, and therefore as
justly

justly put to death by her son. It is true indeed, the king had intended to poison, not the queen, but HAMLET ; but neither the court, nor HAMLET himself, knew this ; none but LAERTES was privy to it ; and as he immediately expired without saying more, the secret was to last for ever.

HAMLET, therefore, could have but little cause to fear that he should leave a wounded name behind him for thus revenging his mother's death. What troubled him, was the thought that posterity would condemn him for not having, before that time, revenged the murder of his father. This was the reproach with which he had often charged himself ; for at the beginning he had resolved to act quite otherwise, and had expressly promised to his father's ghost, with the utmost speed to avenge the murder.

Haste me to know it (said he in the first act) that I with
wings as swift
As meditation or the thoughts of love,
May sweep to my revenge.

His fervent desire now therefore, was, that HORATIO, who knew all, might survive him, not merely to reveal the murder of his father, but to make known to all men the infinite indignation which this excited in him, and the plan of vengeance which he had laid. HORATIO, for this purpose, would describe the two great and leading features in the character of HAMLET, pointed out by the finger of SHAKESPEARE himself, that " noble heart," and that " sweetness," with which at once he was distinguished. Upon the latter of these two, HORATIO would particularly explain the scheme of counterfeiting madness, which that sweetness had suggested ; and which, at the same time, would save HAMLET from passing for a real madman in the opinion of posterity.

As

As certain critics, however, have thought, some, that there is an incongruity, others, that there is an immorality, in the character of this personage, it becomes a duty in the charitable to justify the poet, and to revive the office of HORATIO, in the defence of his hero.

To understand the character of HAMLET, we had best perhaps take it at two different times, before the death of his father, and after that period; for while the substance is in both the same, the form is exceedingly different.

THE former of these, and which was his radical and general character, was a compound of many particular qualities; an exceeding high elevation of soul, an exquisite sensibility to virtue and vice, and an extreme gentleness of spirit and sweetness of disposition. With these were conjoined the most brilliant and cultivated talents, an imagination transcendently vivid and strong, together with what may be called, rather an *intuition*, than an acquired knowledge of mankind. And there may be added still, a singular gaiety of spirits, which hardly at any after period, the very gloomiest only excepted, seems to have failed him.

THESE being the fundamental properties of HAMLET, we have only to see what effects would be produced upon *such* a man, by the villany of his uncle, the murder of his father, the incest of his mother, and the ghost of his father calling upon him for revenge. These were the dreadful springs which put HAMLET into motion; and in which state, SHAKESPEARE brings him upon the stage.

I SHOULD venture to imagine, (both from the nature of a character so extensive, and from the various motives to action) that SHAKESPEARE had no particular plan laid out in his mind for HAMLET to walk by, but rather meant to *follow* him; and, like an historian, with fidelity to record, how a person, so singularly and marvellously made up, should act; or rather, (to use the

the term employed by the king) to describe the "transformation" which he should undergo. For this purpose, he kept an attentive and an undeviating eye upon HAMLET's previous and general character, (such as he had figured it to be) without any intention to add a single new feature, but only to take in such new aspects of it, such new exertions of his powers, and such new schemes of conduct, as should naturally flow from his new situations.

THIS being supposed, the new colours under which HAMLET appears will be found entirely consistent with the old, and springing lineally from them; an indignation and sensibility irritated to extreme; the deepest anguish; at times a mortal melancholy; a counterfeited madness, in order to wait for opportunities of revenge; and a degree of real phrenzy, to which he seems, more than once, to have been actually driven by the strength of his feelings, through force of which he was sometimes upon the point of betraying his own secret. Still, however, there was neither violence, nor sorrow, nor melancholy, nor madness, in the original and natural state of his mind.

WHAT seems to explain the whole of HAMLET's conduct is the latitude of his character. He was at once a polished gentleman, a soldier, a scholar and a philosopher; as in the exclamation of OPHELIA:

O what a noble mind is here o'erthrown!

The courtier's, soldier's, scholar's, eye, tongue, sword.

At one time, mild, courteous and contemplative; at another, animated with the keenest feelings; upon occasions, all wrath and fire; looking down, at all times, as if from a superior orb, upon whatever was little, insincere or base among men.

Now,

Now, in such an assemblage of qualities, combining to form the broad character of HAMLET, SHAKESPEARE appears to have seen, that they were balanced in such an opposite manner, that one class of them should counteract, and render inefficient the other. It is this that suffered nothing to be done; it is this that constantly impeded the action, and kept the catastrophe back. Resentment, revenge, eternal indignation, stimulated HAMLET at one moment; at the next, we have the mere unbending and recoil of these passions; and not only this, which was transient, but there followed, almost at the same instant, that gentleness which so seldom left him. From this, he could not, at any time, act in cold blood; he could strike only in the fiercest moments of provocation; then "could he drink hot blood!" In the general tenor of his mind he could do nothing; he was like SAMSON, when his strength was gone from him.

MEANWHILE, he is almost constantly chiding himself for *dull mettle, dull revenge, want of gall*; a self-reproach which, in some scenes, breaks vividly out; as upon the occasions where he saw a mere player weeping over HECUBA, and when he was told that the delicate prince FORTINBRAS was marching at the head of his troops to risk his life for an "egg-shell." HAMLET, in short, was not formed for action. Upon the fluctuation of his mind between contriving and executing, between elevation, sensibility and gentleness, hangs the whole business of the tragedy.

IN such a state of HAMLET's frame, the project of counterfeiting madness occurred to him with great consistency. It was a device to which his nature led; bent upon vengeance; destitute of resolution directly to gratify it; assuming therefore the cloak of insanity, in order to lull suspicion, and to watch at leisure for those occurrences which time or chance might present. To secure, by this fiction, his personal safety was, in

no

no degree, his view ; for “ he did not set his life at a pin’s fee ;” but, by means of his life being preserved, to embrace the opportunities of revenge. It was from the same softness in his nature, that he afterwards strove to make himself believe, that his father’s ghost might be the devil trying to “ abuse him ;” and which suggested to him the stratagem of getting a play to be performed before the king.

HIS anxious adherence to the project of counterfeiting madness, to which he made every thing else give way, explains his *rudeness*, as Dr JOHNSON calls it, to OPHELIA ; for to deceive the beloved OPHELIA into a belief of his madness, and to insult *her*, was the surest of all means to make it believed that he was really mad. And this also accounts for his making her brother LAERTES believe, that the rough treatment he gave him at his sister’s funeral, proceeded not from love to OPHELIA, its true cause, but from distraction ; and which is ridiculously called by Dr JOHNSON, a “ falsehood unsuitable to the character of a good or a brave man.” HAMLET was then in the very presence of the usurper, and, on that account, industriously “ proclaimed,” that what he had done, proceeded from madness.

CONNECTED with this point, it has been thought vain by some critics *, to justify SHAKESPEARE in his making HAMLET forget (as they think) OPHELIA so soon after her death ; instead of which, he should have waited, they say, for the effect which time has upon the change of feeling ; and Dr JOHNSON has remarked that “ time toiled after him in vain.” But I should apprehend that this is entirely to mistake the character. Time toils after every great man, as well as after SHAKESPEARE. The workings of an ordinary mind keep pace indeed with time ; they move no faster ; they have their beginning, their middle, and their end ; but superior natures can reduce these into a point. They do not indeed suppress them ; but they suspend, or they lock

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them

* Mirror, &c.

them up in the breast. It is the very mark and prerogative of a great soul, upon great occasions to outrun time, to start at once, without sensible transition, into another period. Even a common foldier, in the heat of action, were his dearest companion to fall by his side, would not (although he could) drop his arms and mourn over him. In a similar state, but infinitely more interesting, was HAMLET at this time. And if doubts should still be entertained about the existence of HAMLET's love to OPHELIA after her death, the question can be brought to the shortest issue. HAMLET himself will answer, That his love for OPHELIA was greater than ever. When LAERTES, half-delirious himself with grief for his sister's madness and death, leaped into her grave, and imprecated "ten times triple woe upon the "curfed head of him (HAMLET) who had deprived her of her "most ingenious sense;" HAMLET burst upon him at once from his concealment, like thunder from a cloud;

What is he whose griefs
 Bear such an emphasis? whose phrase of sorrow
 Conjures the wand'ring stars, and makes them stand
 Like wonder-wounded hearers? This is I,
 HAMLET the Dane— *[leaps into the grave.]*
 Why, I will fight with him upon this theme
 Until my eye-lids will no longer wag.
 I loved OPHELIA; forty thousand brothers
 Could not, with all their quantity of love,
 Make up my sum. What wilt thou do for her?
 — Come, shew me what thou'lt do.
 Woo't weep? woo't fight? woo't fast? woo't tear thyself?
 Woo't drink up Eisel, eat a crocodile?
 I'll do't—Dost thou come hither but to whine?
 To out-face me with leaping in her grave?
 Be buried quick with her, and so will I.
etc.

His

His love had been only the deeper embosomed ; it had become too sacred to be seen ; and like fire, when pent up, it had acquired greater force.

THERE seems also to be a mistake in the attempt which some * have made, in justification of SHAKESPEARE, to reconcile the melancholy to the jocularity of HAMLET. For his jocularity, I should rather conceive, sprung more from the elevated than from the melancholy parts of his nature. He was not, strictly speaking, a melancholy man ; although it be true that, at times, he was plunged into a state of genuine and deep dejection. In such a state, and in certain kinds of it, we have heard of the *joy of grief*, and can understand it—something sweetly grave and pensive ; but the *gaiety* and *pleasantry* of grief are things which probably never existed. It is, on the other hand, the exclusive act of a great mind, to make truce with sorrow ; to dismiss the deepest anguish ; to put mirth in its stead ; and HAMLET, in such scenes, was only for a little resuming his strength. Even the melancholy which is ascribed to him, and which indeed he ascribes to himself, was often not melancholy, but wild contemplation and reverie.

THERE are many similar instances of the connection between elevation and pleasantry, both in the character of nations and of individuals. The Spaniards, for example, are described to be of a grave and lofty spirit ; yet among no people is there more humour. Individuals of this cast are not unfrequently to be met with in every country. MOLIERE may be instanced, who was one of the most serious and respectable men that ever lived ; and yet no writer has had such a propensity to farce and buffoonery ; his plays being in general just the counter-parts of himself. It is upon such principles, I would venture to explain the pleasantries of HAMLET ; in which he rose up, at times,

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from

* Mirror.

from an abyfs of anguish, to make a mere sport of human sufferings.

THE causes of HAMLET's dilatory progress have been already pointed out in general; and the more narrowly we take a view of him, the more we shall always find his sensibility to be, in the first moments, such, as led to instant and mortal action, while his gentleness, like an equal weight on the other side, counteracted its whole force. SHAKESPEARE has described him, in the cool state of his mind, as averse, and even shocked, at the thought of killing. His mother said, that, in this state, he was "as patient as the female dove." If we take his own account of himself, he was a coward:

— Now, whether it be
Bestial oblivion, or some craven scruple
Of thinking too precisely on the event—
A thought which, quartered, hath but one part wisdom,
And ever three parts, coward—I do not know,
Why yet I live to say, This thing's to do.

THERE was a superstition also in HAMLET, which prevented him from putting the usurper to death, when in the act of prayer. For the reason he himself gave for deferring this, was, that if he killed the king in the midst of his devotions, he would in fact be doing him a good service, "sending a villain to heaven."

Why, this is hire and salary, not revenge.
He took my father grossly, full of bread,
With all his crimes broad blown, as flush as May;
And how his audit stands, who knows save Heaven?

He put up his sword, and waited till he should find him engaged

gaged in drink, rage, incest, gaming, fwearing, or other act that had “ no relish of salvation in’t ;”

Then trip him, that his heels may kick at Heaven,
And that his soul may be as damn’d and black
As hell, whereto it goes.

THE sentiments in this last passage have been considered as the most difficult to be defended in the whole character of HAMLET. Without having recourse to a defence of them upon the principle of retaliation, and other pleas, there seems to be ground for an explication of a very different nature, founded upon what appears to be the real character of this personage, and altogether exculpating him from the charge of those horrid dispositions which he has been supposed here to possess.

HAMLET, in these lines, (if it may be allowed to offer a conjecture) was really *imposing* upon himself *; devising an excuse for his aversion at bloodshed, for his cowardice, his “ craven scruple.” In the first moments, he proposes instantly to strike—“ now I’ll do’t.” His ordinary softness immediately recurs; and he endeavours to hide it from himself, by projecting a more awful death at a future period, but which he seems never to have thought of afterwards, and which was not at all consonant to his general character. Indeed, what the king himself said of him afterwards, upon basely proposing to LAERTES to use “ a sword unbated,” is a sufficient proof that there was nothing dark or malignant in his nature.

— He being remiss,
Most generous, and free from *all* contriving,
Will not peruse the foils.

THE

* SINCE writing this Essay, I have the pleasure to find, that the same idea has occurred to Mr Professor RICHARDSON, in his additional observations on HAMLET; and which he has successfully enlarged upon.

THE execution of his two school-fellows, ROSENCRANTZ and GUILDENSTERN, in consequence of an artifice which he contrived against them, has also drawn the censure of critics. But is there any evidence that HAMLET thought them unacquainted with the mandate which they carried for striking off his head in England? Whether they were in fact privy or not privy to this, is not the question. Did not HAMLET believe they were privy to it, and even were fond of it? "Whom I will trust" (said he early) as I will adders fanged." And speaking afterwards to his confident HORATIO, he added,

Why, man, they did make *love* to this employment;
They are not near my conscience.

That is, my conscience does not upbraid me; the cruelty lies not with me, but with them. And in this conduct of HAMLET, to the companions of his early days, does SHAKESPEARE prove his skill in human nature; the strongest hatred succeeding, upon such occasions, to the strongest friendship: For that they were his school-fellows, he would consider, and with reason, as a great aggravation of their guilt.

IN all other respects, the character of HAMLET stands confessedly fair and great. He moved in the highest sphere of men; possessed an elevated and comprehensive mind; penetrated through every character; knew the whole of human life; saw nothing noble but virtue, nothing mean and base but folly and vice. Speaking to HORATIO,

Since my dear soul (says he) was mistress of her choice,
And could of men distinguish, her election
Hath sealed thee for herself; for thou hast been
As one in suffering all, that suffers nothing;
A man that fortune's buffets and rewards

Hast

Haft ta'en with equal thanks : and bleft are thofe
 Whofe blood and judgment are fo well co-mingled
 That they are not a pipe for fortune's finger,
 To found what ftops fhe please. Give me that man
 That is not paffion's flave, and I will wear him.
 In my heart's core.

Men praife in others what they love and poffefs in themfelves ;
 and HAMLET was here drawing fome of the outlines of his own
 character.

To the principles of morality and a confummate knowledge
 of mankind, he joined the accomplifhments of learning and
 the graces of life. His eloquence was fuch as great orators only
 have poffeffed, rich, tropical, daring, ardent, vehement. The
 directions he gives to the players, are models of tafte and laws
 for the ftage. His wit and fancy feem to have belonged only
 to himfelf. Even in his character of foldier and hero, and
 which I all along confider as his weaker part, an intrepidity
 breaks forth at times beyond what is human ; as appears in the
 ghofth-scenes, where his courage grows with danger ; where he
 is not only unterrified, but fports with what appals the reft of
 mankind.

THE HAMLET of SHAKESPEARE, taken all in all, feems
 thus to be the moft fplendid character of dramatic poetry ;
 poffeffing, not one or two great qualities, the ordinary compafs of
 the heroes in tragedy, of a LEAR, an OTHELLO, a RODRIGUE,
 an HORACE, but comprehending almoft the whole of what is
 beautiful and grand.

THE miftakes which critics feem to have fallen into, can be
 all traced perhaps to partial and fide-views which they have
 taken of HAMLET ; but which can neither explain his whole
 character, nor fufficiently account for the intereft which is ex-
 cited.

SENSIBILITY,

SENSIBILITY, for example, making a striking figure in this character, has been thought to be the sole basis of it, without considering that mere sensibility cannot excite a tragic interest; cannot attach; cannot overwhelm; and indeed seems unable to make any other impression but that of pain, when viewed apart from the cause in which it acts, and from the other qualities with which it is conjoined. Neither can a SENSE OF VIRTUE be admitted as the only ruling principle; for even this does not sufficiently account for the interest; and both systems fail in explaining the inefficiency of the character, which results from the soft and amiable, and hence, in a great degree, the interesting parts of it. For in both, the gentleness of HAMLET, the great impediment to the action, has been overlooked; although, to supply its place, a weakness and irresolution, sometimes deduced from excessive sensibility, sometimes from melancholy, are recurred to in the former, but which are certainly of a transient duration, while gentleness was a permanent quality; and, in the latter, while the same office is allotted to irresolution, the irresolution itself is deduced from the moral faculty, suspending and abating repentment; but which surely would suppose, what cannot be admitted, that the pious and noble revenge of HAMLET had something morally blameable in its nature. Two elegant and ingenious publications are here alluded to*; but in both of them, the ground taken is, I humbly think, too narrow; and this seems to have been the cause, why recourse has been had to refinements, in order to stretch it out. Facts certainly supply us here with two principles at least, sensibility and gentleness; and there hence seems no necessity for resolving the whole conduct of HAMLET into the formèr, as is done in one of these publications. Neither are we to recur, sometimes to
the

* THE ONE anonymous, in No. 99. and 100. of the *Mirror*; the other, the *Analysis of HAMLET*, by MR RICHARDSON.

the one principle, sometimes to the other, taken separately, in order to explain HAMLET. It is the *struggle* between the two, upon which his conduct hinges. This appears in the very opening of the tragedy.

The time is out of joint ; Oh cursed spight !
That ever I was born to set it right.

Here, sensibility and gentleness may be said to speak in one and the same breath ; a proof that their operations were not successive, but co-existent ; and reigned nearly equal in power in HAMLET's breast.

ELEVATION seems to have been nearly as much overlooked as gentleness. Yet between these two was HAMLET almost always moving. For his sublimity of soul seems to have been the very spring which prompted and whetted his sensibility to the quick. SHAKESPEARE in one phrase, " a noble heart," meant to express both ; as they were in fact intimately conjoined, and acted at once, together.

THERE is an impression which great accomplishments and splendid talents, independent of every thing else, especially in a tragic cause, never fails to make upon mankind. These shine most powerfully in the character before us ; and probably have contributed much to the charm which has made audiences hang upon HAMLET. The world, for the first time, saw a *man of genius* upon the stage ; and the interest which the spectators have taken, and perhaps for ever will take, receiving an addition from this cause, arises thus upon the whole, from the many different sources which the poet, by a superlative effort of talents and of skill, has combined together.

THE fault (if any) of the play seems to lie in this, that there is not the usual interest excited in it, for the final event. What SHAKESPEARE's purpose in this respect originally was,

cannot be affirmed. It is possible, that, finding the character of HAMLET to grow upon him, he varied in the progress from what he had intended in the outsetting of the play, and giving to HAMLET, on this account, a fuller scope, (but without departing from the character) he eventually threw more interest into the person than into the plot. Whatever may have been the cause, we see the effect,—HAMLET, in his sole person, predominating over, and almost eclipsing the whole action of the drama. It is he that draws the admiration; it is he that engrosses the concern; all eyes are turned more and more to him; HAMLET is wished for in every scene; king and queen, incest and murder, as objects of tragic attention, vanish almost away; the moment HAMLET's own fate arrives, the play is ended. The interest which the hearts of men take in the principal character of this tragedy, stands thus in competition with the laws of the drama; and it becomes a problem, which of the two, the means or the end, should preponderate.

ON account of the interest being transferred from the action to the agent, the moral, taking the same course, is to be drawn rather from the particular conduct of HAMLET than from the general business of the play. But what that particular moral is, may be difficult to ascertain. We may say, perhaps, that from the conduct of HAMLET, it appears, how unfit for the work of revenge are the qualities of a soldier and hero, when conjoined with those of a scholar and philosopher; yet we cannot presume to affirm, that it was SHAKESPEARE's object merely to exemplify this, or even to conceive, that he limited himself to any single object or moral. Those things which seem to have been uppermost in his mind, and which he has made to shine with most light, are the charms in the personal character of HAMLET. Enamoured with these himself, it seems to have been his chief purpose to raise the same passion in his audiences. That he has intimated this, by his interpreter HORATIO, only
in

in one or two lines at the close of the play, is to be ascribed to his judgment. The purpose which the dramatic poet has in view, is to be found out by the best of judges, the feelings of the spectators. From a superior skill upon this point, *RACINE* has merited the praises which have been given him, while, from a failure in it, the great *CORNEILLE* has been deservedly blamed.

END OF THE SECOND VOLUME.

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E R R A T A.

Phyf. Cl. page 10. line 14. for properly read improperly.

————— 131. line 5. and 4. from the bottom, and also in the last line, for EY and EZ read Ey, Ez.

————— 134. line 5. for $8(AD^2+BD^2+CD^2)$ read $4(AD^2+BD^2+CD^2)$.

————— 159. in the note, line 1. for $\frac{m-n}{8}$ read $\frac{m-n}{9}$.

————— 204. line 5. from the bottom, for $(100)^2$ read $(10)^2$.

Lit. Cl. page 9. line 4. for vindicates read indicates.

[Omitted in the List of Donations, page 80.]

By Mr Robert Kerr, surgeon, Edinburgh.

Elements of Chemistry, by M. Lavoisier, translated from the French. 8vo. 1790.

DIRECTIONS FOR THE BINDER OF VOL. II.

The Binder is desired to observe, that the Vol. consists of Three Sets of Pages, to be arranged in the following order, immediately after the TABLE OF CONTENTS, *viz.* PART I. containing the HISTORY of the SOCIETY: PART II. containing, I. PAPERS of the PHYSICAL CLASS; II. PAPERS of the LITERARY CLASS: And that the Plates are to be placed as follows, *viz.* the Plate entitled *Quassia Simaruba Mas*, facing page 82. *Phyf. Cl.* and *Quassia Simaruba Feminea*, immediately after it; the Plate entitled *Craig-Phadrick*, facing page 32. *Lit. Cl.* and *Dun-jardel* immediately following; and the other five according to the references marked on them.





